Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1956

TECHNOLOGY DEPT.

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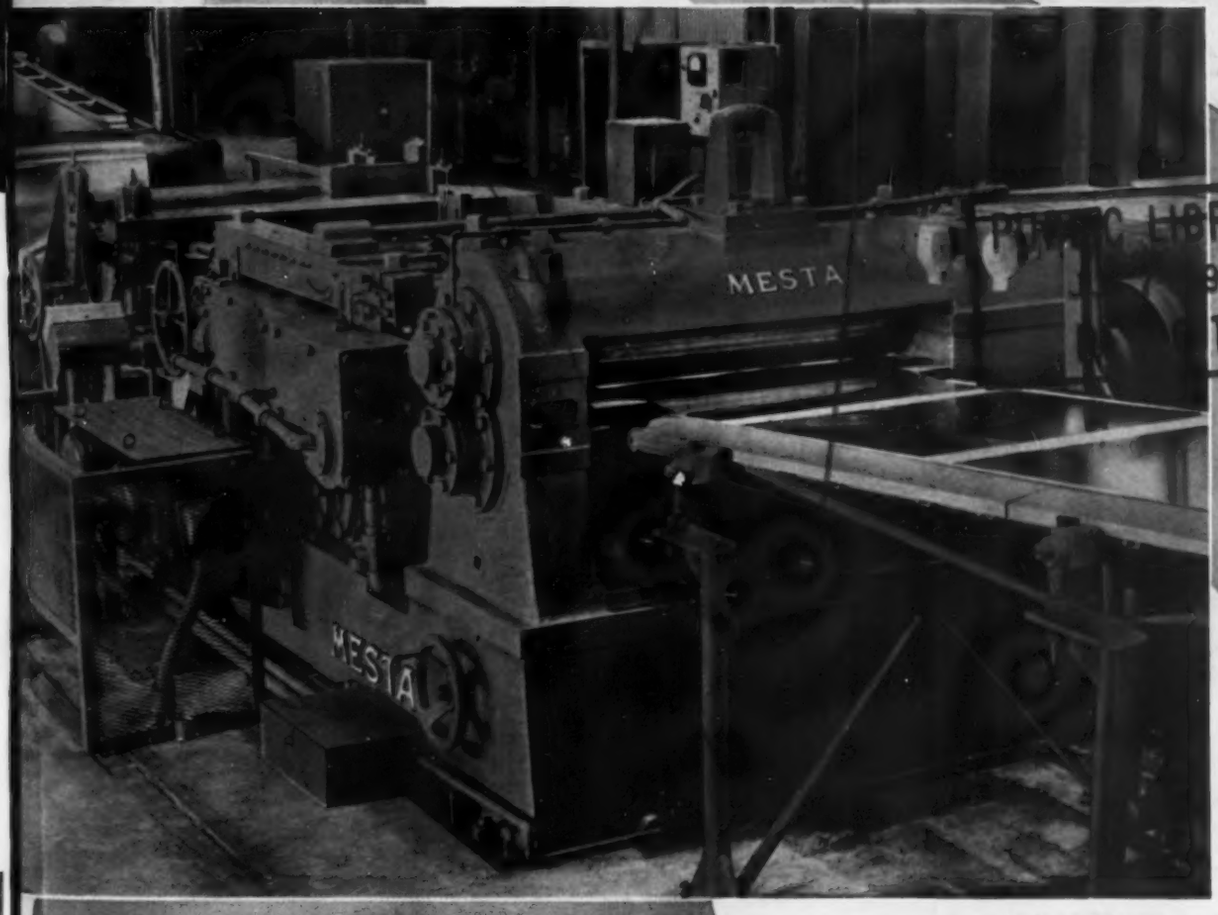
Shearing* LINES

Designed and Built by MESTA



MESTA 42" High Speed Rotary Flying Shear and Leveller shearing tin plate at 1,200 ft. per minute on an Electrolytic Tinning Line at Tennessee Coal & Iron Division of United States Steel Corporation

*HIGH-SPEED SHEARING, SIDE TRIMMING and SLITTING EQUIPMENT for SHEET and TIN GAUGE STRIP STEEL

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

MESTA — THERE IS NONE BETTER

CHOICE OF THE MILL INDUSTRY...
CUTLER-HAMMER'S 505 AISE D-c BRAKE

★ Simplified Design ★ Rugged Construction ★ Dependable Performance
★ Ease of Installation and Maintenance

Compare the Cutler-Hammer 505 D-c Brake with any other, and instantly you will appreciate why the 505 is the choice of the mill industry. The service proven over-the-wheel pull rod is the simplest means of transmitting the maximum braking force. Notice only one operating coil, only one torque spring, and only one torque adjustment. Gone is the clutter and multiplicity of pins, linkages and cantilevers common to other brakes. This is simplicity . . . simplicity in design and construction which insures you simplicity in operation, installation and maintenance. It is common sense the cleaner the design, the less complicated the design, the more dependable the performance . . . and in the Mill Industry dependable performance is paramount.

Each of the ten major components of the Cutler-Hammer 505 D-c Brake embodies the principle of rugged construction. Check the shoe-lever and base plate joints. Here troublesome pivot pins have been eliminated, and replaced by oversize bearing sockets which cut bearing pressure to a fraction of that found in other mill brakes. The tough, weatherproof capsule coil will out-perform all others. The brake shoes have heavy duty riveted linings. The wheel is specifically designed for braking service using only the finest high strength ductile iron. Ductile iron has superior wear characteristics and will not flake even at high temperature service.

Because of the simplified design and rugged construction it is natural to expect dependable performance, and you get it with the Cutler-Hammer 505 D-c Brake. The 505 is direct-acting, and exclusive one-to-one leverage provides maximum braking effectiveness.

CUTLER-HAMMER
MOTOR CONTROL
C-H

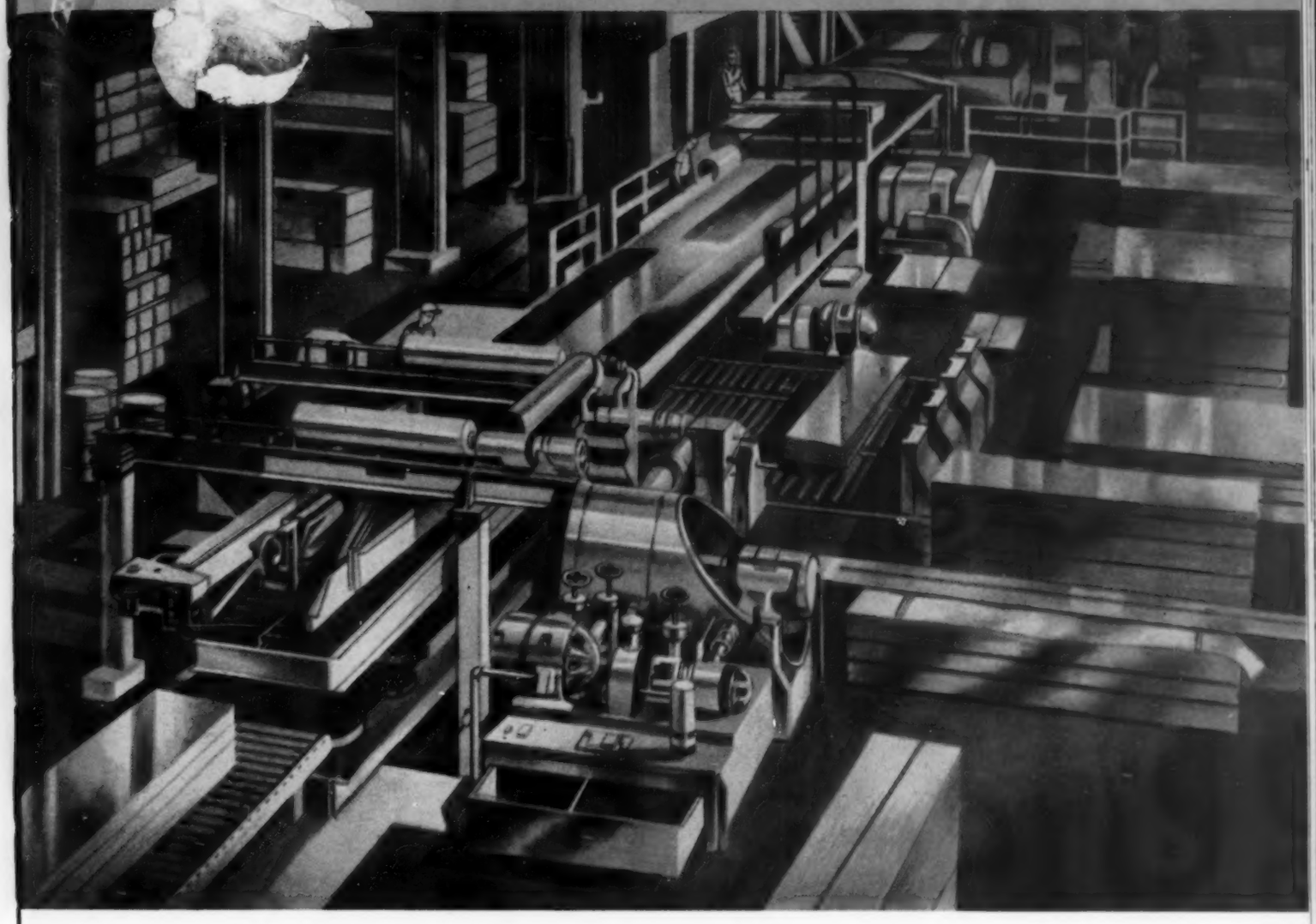
Take each feature of the 505 separately or all collectively; the C-H 505 D-c Mill Brake was designed and built to out-perform, out-last all others.

Ease of installation and maintenance is a major consideration in any device destined for mill application. Here too the Cutler-Hammer 505 is the choice of the industry. Because of the simplified design and minimum number of parts, the 505 can be completely assembled in a matter of minutes with ordinary hand tools. Capsule coil can be quickly changed or reversed while on the job. Only two adjustments required to put the brake into operation. Brake linings can be serviced quickly without disassembly of the brake. No special tools required for any maintenance operation.

For complete information write for the descriptive literature detailing construction, torque ratings, types, sizes and service characteristics. CUTLER-HAMMER, Inc., 1255 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

54 YEARS OF DESIGNING AND BUILDING EQUIPMENT



CUT, SHEAR, TRIM, SLIT, STRAIGHTEN, COIL, UNCOIL, SCRUB, DRY, CLEAN, PILE, CONVEY...

AETNA·STANDARD MAKES THE EQUIPMENT

• In the general category of Finishing Equipment, Aetna-Standard designs and builds many different types of products and equipment.

Major Aetna products include complete lines such as Side Trim and Shear, Automatic Gauging and Classifying. Individual items include such products as the patented Sheet Classifier, Levellers, Payoff and Tension Reels, Pilers and other machines or equipment for cutting, shearing, trimming, slitting, straightening, coiling, uncoiling, scrubbing, drying, cleaning, piling or conveying.

We can build equipment for processing any conventional shape, size or weight material.

AETNA•STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. **PLANTS: ELLWOOD CITY, PA., WARREN, OHIO**

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC

BLAW-KNOX makes what it takes

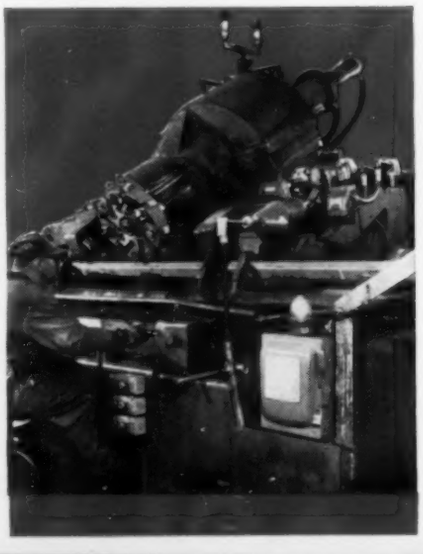
for continuous, mechanical chipping

The Continental Chipper with auxiliary equipment is a complete mechanical system for sorting, handling, inspecting and chipping billets. This integrated system has demonstrated in-service cost savings over manual conditioning. It represents a wise investment in long range modernization programs for conditioning for subsequent rolling in merchant and bar mill operations.

Product quality improvement is immediate, positive. Precise chipping is accomplished by a non-traveling cutter head under which the billet moves in a fashion similar to a milling machine. All chipping is done at close range, immediately in front of the operator. This single operator, located in front of the cutter head controls the entire operation including all material handling.

The chipper is equipped with special interlocking devices which eliminate unsafe operation. Usual chipping bay hazards such as high pressure air lines, improperly handled chisels, and flying chips are removed. The Continental Chipper accommodates billets up to 30 feet in all merchant and bar mill sizes.

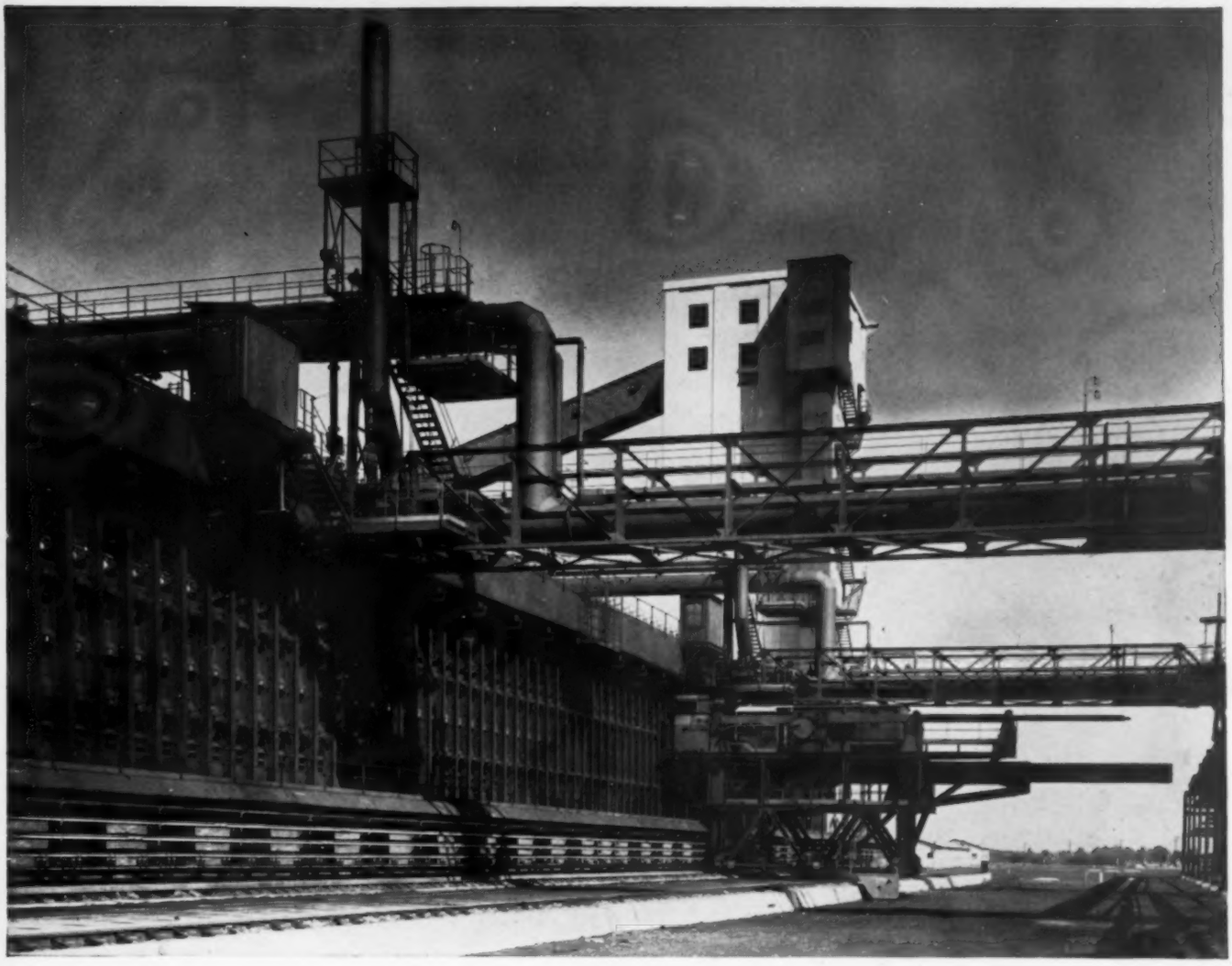
For complete details, write for illustrated booklet.



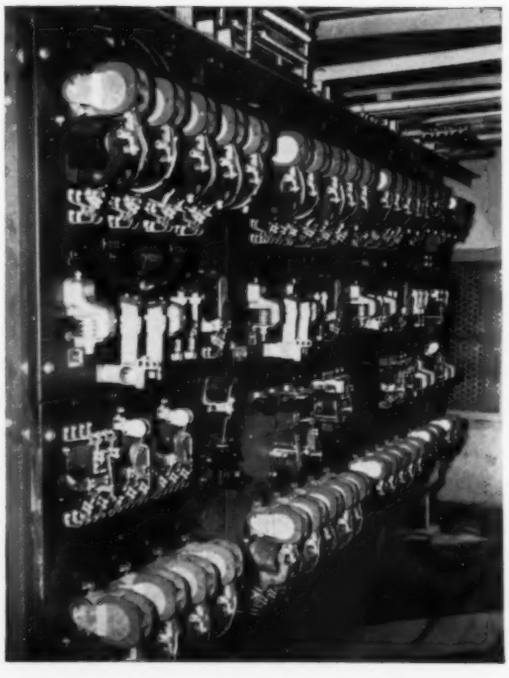
50th Anniversary
BLAW-KNOX
1906-1956

BLAW-KNOX COMPANY
Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

CONTINENTAL



Giant pusher for 76 coke ovens is CLARK CONTROLLED



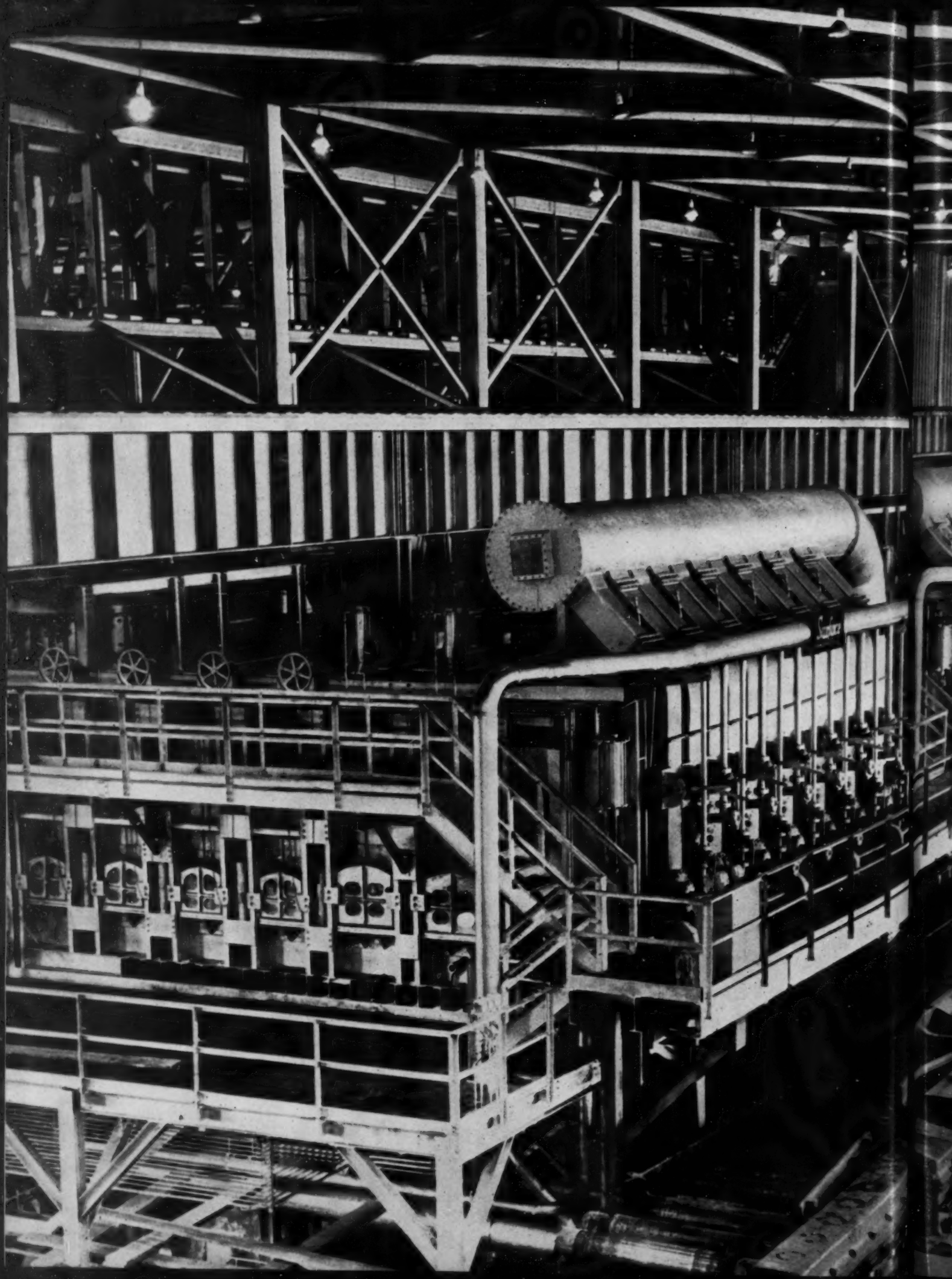
Coke is discharged from this battery of 76 ovens—almost 300 feet long—at the rate of 58 tons per hour. The enormous Clark-controlled pusher moves from oven to oven on a regular schedule, emptying each as it becomes ready . . . Designed and built by the Wilputte Coke Oven Division of Allied Chemical and Dye Corporation of New York, the 300,000 pound pusher depends on Clark apparatus for its precise, dependable operation. The six separate motors, totalling 175 HP, are controlled by a Clark Bulletin 9300 Coke Pusher Control. The special Clark Control Panel is shown at the left.

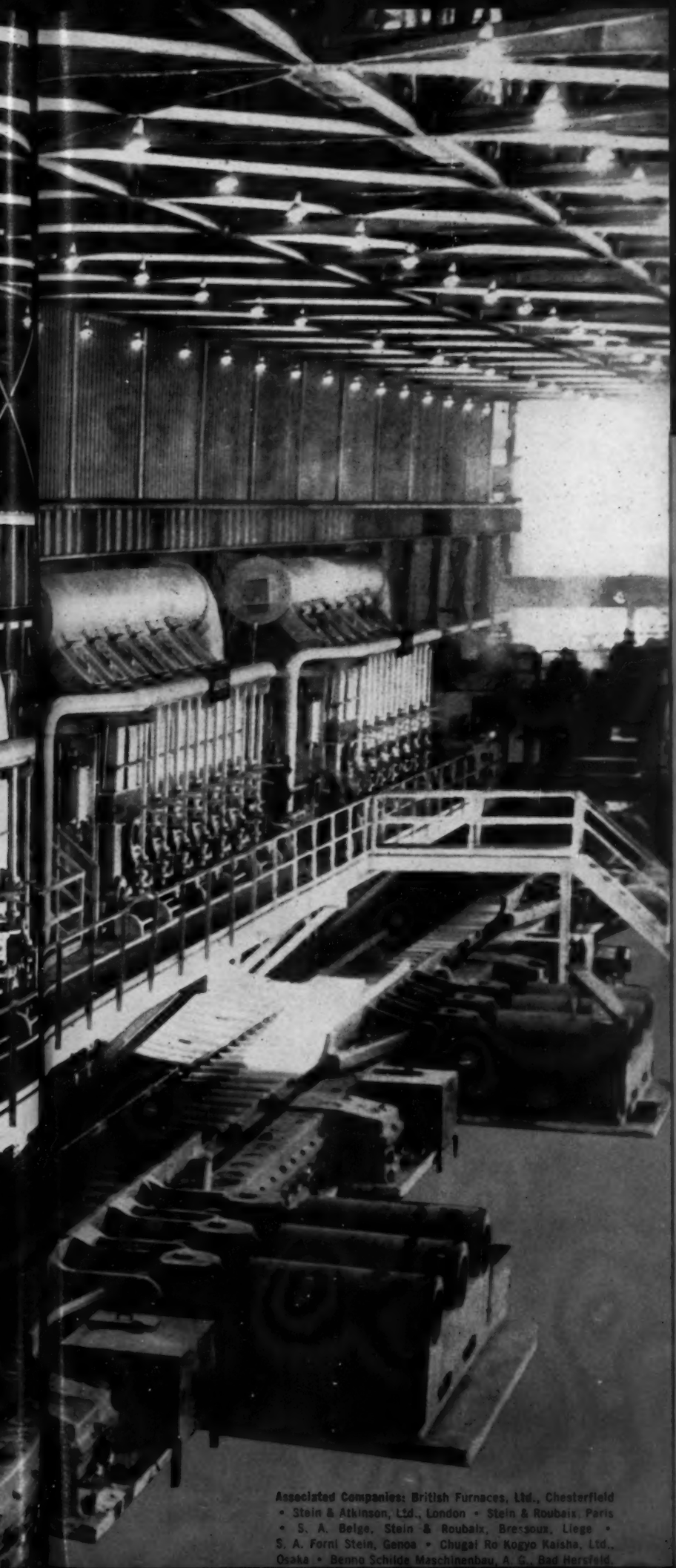
The CLARK CONTROLLER Company

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA . . . CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO





Associated Companies: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld.

200 TONS AN HOUR CONTINUOUSLY

200 tons of steel slabs are heated to rolling temperature every hour, continuously, in each of these Surface monsters—world's largest slab furnaces.

No other furnace today can list all of these features:

1 Cantilever skid supports* permitting unobstructed combustion space for underfiring.

2 Furnace lines and burner design which provide high heat input from the moment the slab enters the furnace.

3 Built-in control* to prevent intermingling of gases from upper and bottom zones, providing better control of heat application, and preventing overheated slab end.

4 Anticipatory control which reduces temperature head when rate of slab discharge decreases.

5 Air preheat up to 1100°F.

6 Television signal to pusher pulpit, informing operator of the exact position of the leading slab.

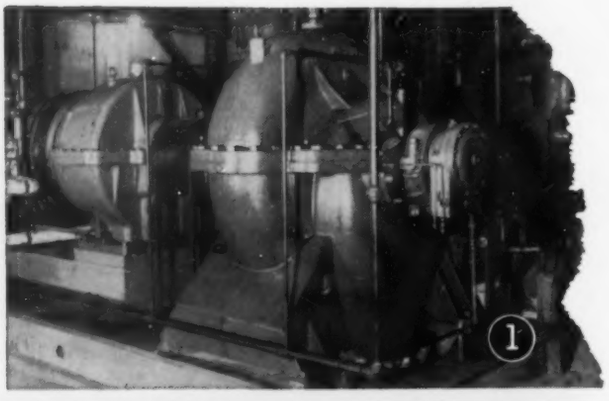
About the only conventional feature in these giants is the fact that the slabs are pushed in one end and out the other.

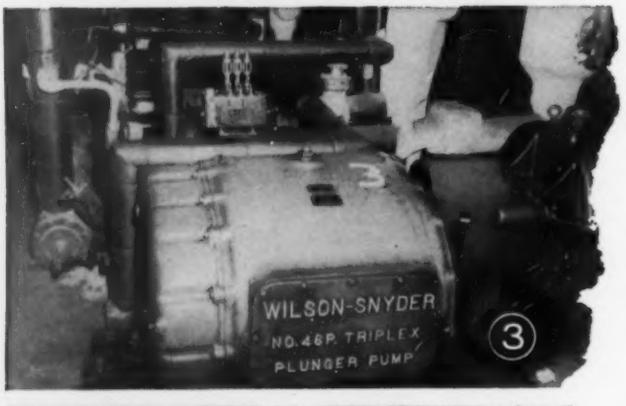
This is another demonstration that, at Surface, unconventional thinking and conventional experience are a productive team for the steel industry. Surface Combustion Corporation, Toledo 1, Ohio.

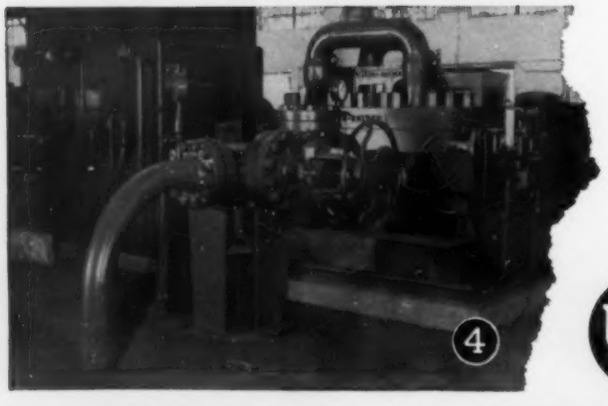
*patents pending

Surface
STEEL MILL EQUIPMENT

DO YOU KNOW . . . that Wilson-Snyder Pumps are specifically designed for the rugged service requirements that steel mill duty demands?







YOU KNOW the proper evaluation and application of the best equipment for the job to be done pays off in the most trouble-free performance and minimum maintenance cost.

BUT DO YOU KNOW that Wilson-Snyder Pumps are designed to give you this kind of performance. Designed and constructed of the best materials for your specific job with that extra margin that means **Dependability Around the Clock.**

Wilson-Snyder Pumps are not "general service" pumps. We invite your feature-for-feature comparison with any pump on the market.

Here are four varied examples of Wilson-Snyder Pumps—designed for the job:

1. MILL SUPPLY PUMP—Unit illustrated is a 30" bottom suction, 24" side discharge turbine driven centrifugal pump capable of handling 40 million gallons per day at heads up to 180 feet for supplying general mill service water requirements.

2. HIGH PRESSURE HYDRAULIC PUMP — Horizontal duplex double acting outside end packed plunger type pump for 2500 PSI hydraulic service—especially designed to withstand shock loading resulting from this type of service.

3. COKE OVEN TAR TO BURNERS —Horizontal triplex single acting outside end packed plunger type pump for pumping hot coke oven tar to burners. Liquid end of pump is designed especially for handling abrasive laden hot tar, and power end is heavy duty steel mill type.

4. HYDRAULIC Ddescaling PUMP—Unit illustrated is a 6" 6-stage opposed impeller type centrifugal pump driven by a 1500 HP motor designed especially for hot strip and slab mill descaling service for pressures up to 1500 PSI.

Many Wilson-Snyder Pumps installed more than 50 years ago are still in continuous service. Our experience in the design and manufacture of pumps for an extremely wide range of steel mill and metal working applications qualifies us to design and build pumps to satisfy your most exacting requirements.

Write for Catalog containing complete specifications on

WILSON-SNYDER PUMPS

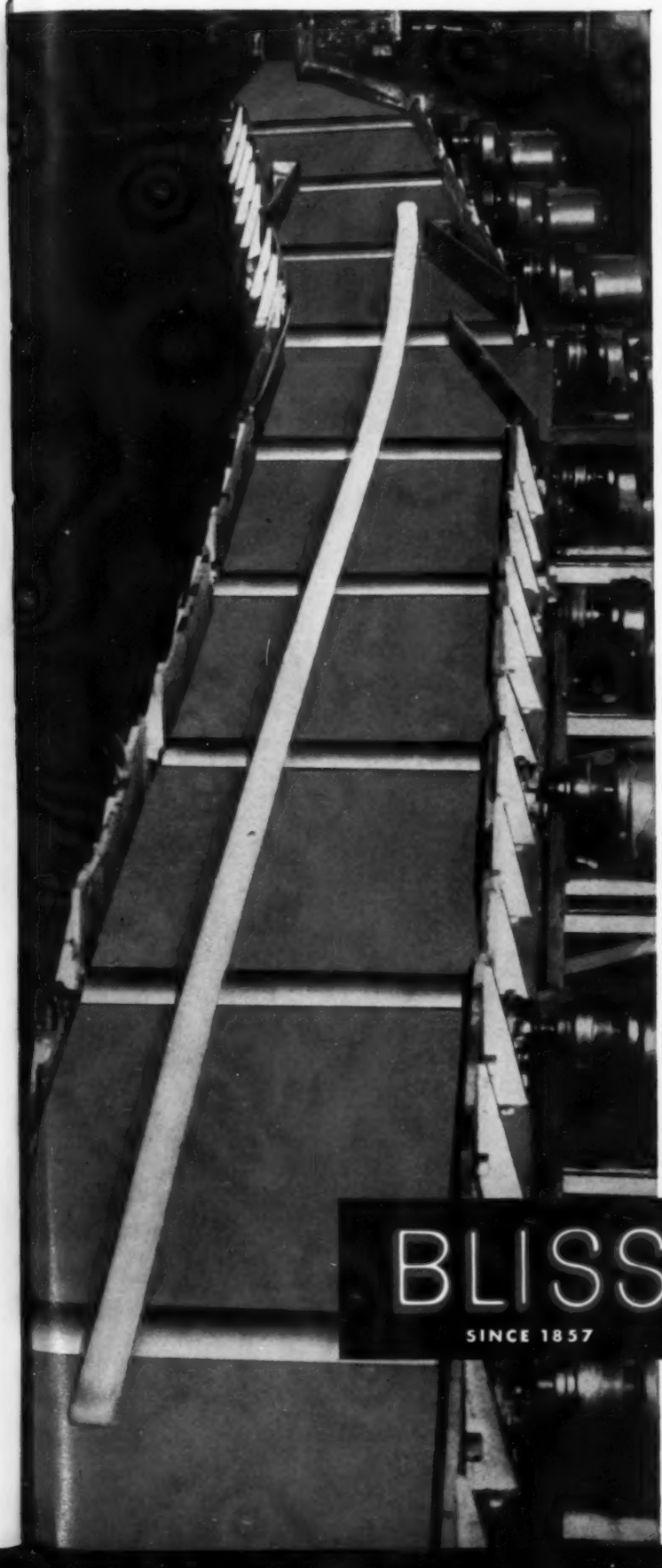
and let us quote on your requirements

WILSON-SNYDER WORKS, Braddock, Pa.
OIL WELL SUPPLY DIVISION
UNITED STATES STEEL CORPORATION

USS

UNITED STATES STEEL

Special powered-roller tables speed handling at new Merchant Bar Mill



To meet growing demands for specialized bar products, Phoenix Manufacturing Company mechanized breakdown operations at its new bar mill with three specially-designed Bliss powered-roller tables:

- a "live" table speeds billets from furnace into a three-high roughing mill,
- a tilt table shoves them back into the roughing rolls during breakdown passes, and
- a runout table carries them into the first of six finishing mills.

Designed, built and installed by Bliss, these tables help Phoenix hit top production schedules at lower costs by cutting handling time to the bone. What's more, they're designed for fast, easy maintenance—to keep up a steady, shift-after-shift flow of bar stock.

These powered-roller tables, like all Bliss rolling mill accessory equipment, are built to your specific needs, installed under the supervision of Bliss field engineers and serviced by experienced engineering personnel. Why not get more information on Bliss rolling mills and accessory equipment? Write today for your copy of Catalog 40-A—Bliss' 60-page Rolling Mill Brochure.

Bliss-designed "live" table was installed during mill construction.

E. W. BLISS COMPANY, General Office: Canton, O.
ROLLING MILL DIVISION: SALEM, OHIO
Presses, ROLLING MILLS, Special Machinery

is more than a name
...it's a guarantee

Plants at Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; Midland and Pittsburgh, Pennsylvania; San Jose, California
E. W. Bliss (England) Ltd., Derby E. W. Bliss Co. (Paris), France

You Get MORE

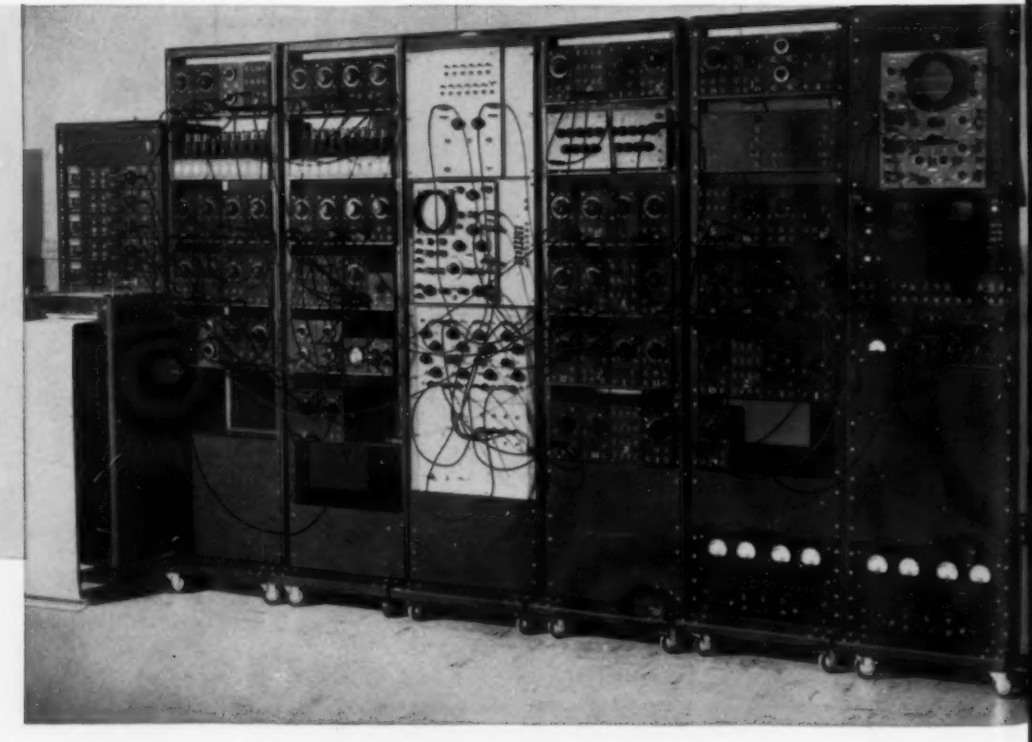
...because ALLIS-CHALMERS "COORDINEERS" the Entire System

EFFECTIVE regulation is more than a matter of good regulator design. It embraces overall *system* design... the integration of interdependent components — generators, exciters, motors, regulators and other control equipment. As manufacturers of a most diversified line of electrical generation, distribution and utilization equipment, Allis-Chalmers, of course, is in a unique position to provide this practical approach to mill regulation.

Allis-Chalmers maintains separate departments, staffed by research, design, manufacturing and application specialists for each product. "Coordineering" results from an interdepartment exchange of ideas and technical information correlated in *one* department specializing in metal producing industry application. In this department, components are matched to meet the requirements of your job. Responsibility for *system* performance rests with one company.

Analytical Facilities Utilized...

System performance is simulated in the computers to get optimum configuration of components. Time constants and exciter ceilings necessary for desired response are established.



LIVE BETTER ELECTRICALLY

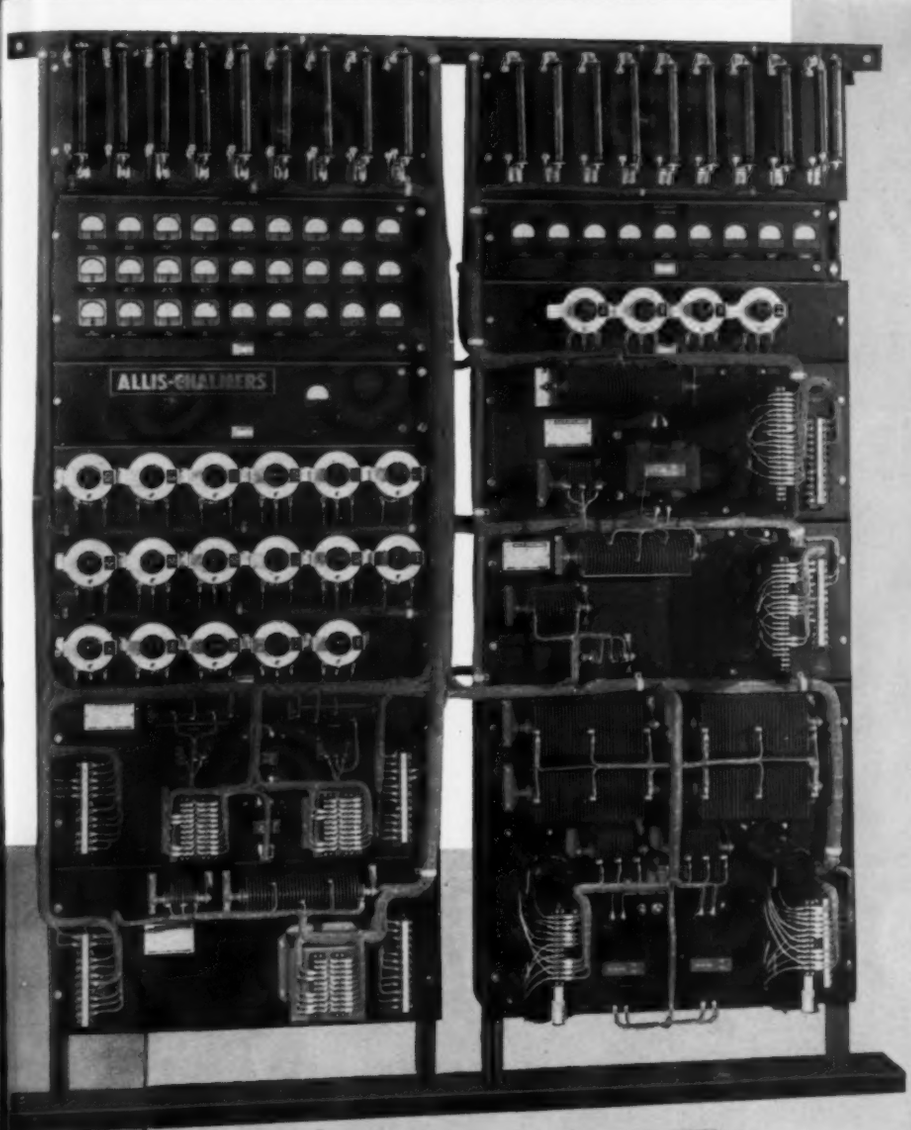
Regulex is an Allis-Chalmers trademark.

ALLIS-

Efficient Regulation

ALLIS-CHALMERS

Regulators



Magnetic Amplifiers

For MILL CONTROL

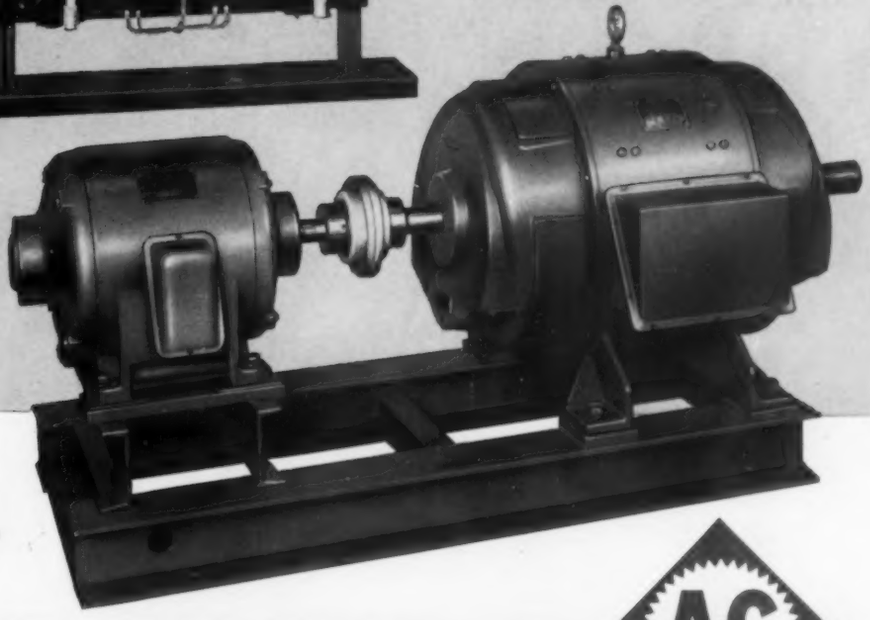
Three Types Available

1 ***REGULEX* Rotating Amplifier** — Applicable where high power levels for reversible output are desired.

2 **Magnetic Amplifiers** — Applicable where low power levels for reversing or high power levels for non-reversing are desired.

3 **Combinations of Rotating and Magnetic Amplifiers** — Each complements the other for maximum regulating efficiency.

Get all the facts. See your Allis-Chalmers representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.



Regulex Rotating Amplifier

CHALMERS

A-C ALLIS-CHALMERS

A-5030

VICTOR R. BROWNING

Mill Type Cranes

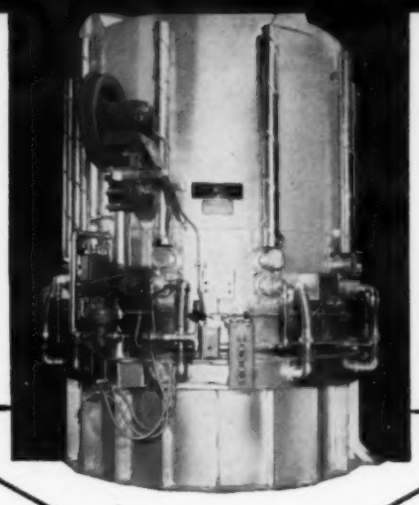
TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

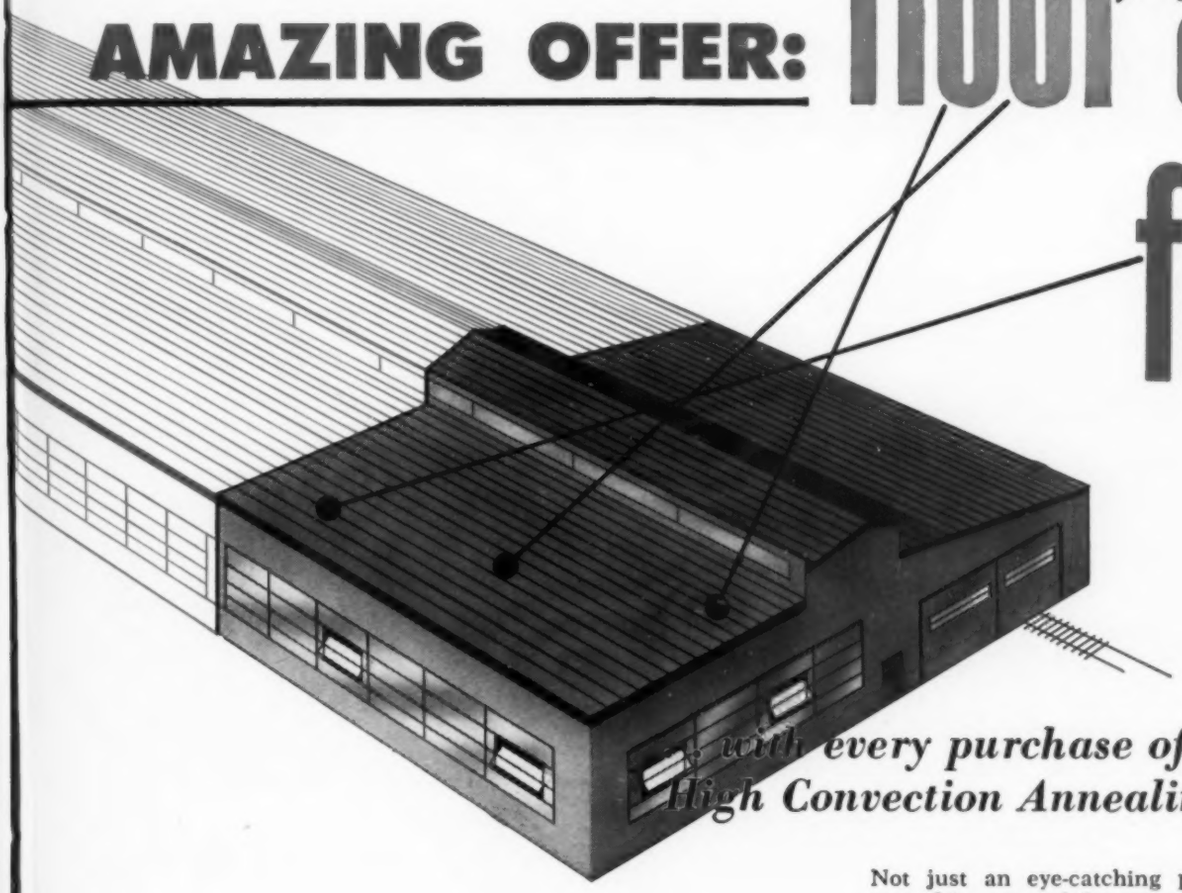
WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES



Industrial floor area free!

AMAZING OFFER:



with every purchase of Lee Wilson High Convection Annealing Furnaces

Not just an eye-catching phrase, this has been proved in many of the nation's foremost steel plants. The Lee Wilson single stack system produces more annealed tonnage per square foot of floor space than any other annealing method in use today.

This means that if you're annealing any sizable tonnage at all, the resultant saving in floor space actually would equal that of a fair size building. That's why we say every purchase of Lee Wilson High Convection Annealing Furnaces gives you extra floor area free!

Let us prove this fact to you. A Lee Wilson sales engineer will be happy to meet with you at your convenience and explain how this equipment saves floor space. He'll give you good reasons, too, why the Lee Wilson Single Stack is the nation's best annealing furnace.

Lee Wilson ENGINEERING COMPANY, INC.

20005 WEST LAKE ROAD • CLEVELAND 16, OHIO

SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

MAKE THE BEST METALS BETTER

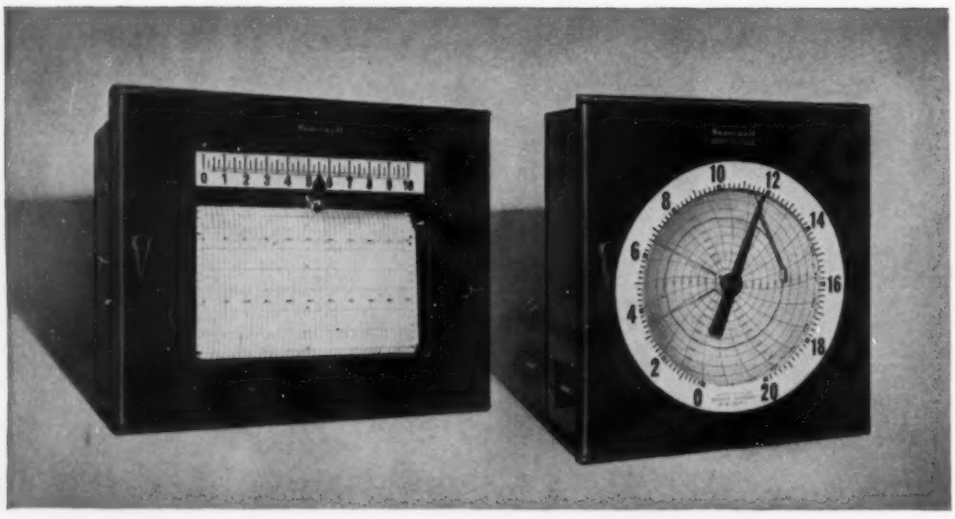
9931

✻ ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

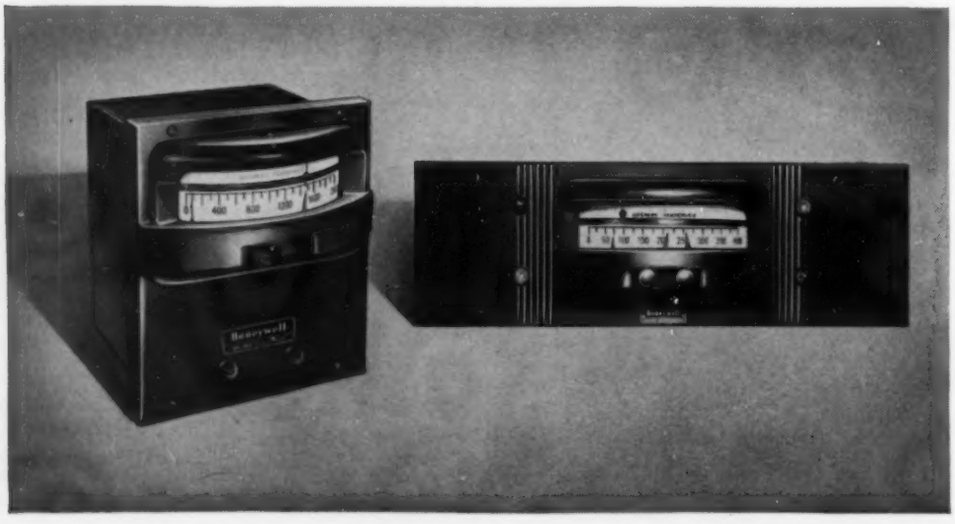
• *for accuracy,*
versatility, price

The Precision Class 15 Line of *ElectroniK* instruments has calibrated accuracy within ±.25% of scale span. Models include strip and circular chart recorders, Precision Indicators, circular scale indicating controllers, Vertical Scale Precision Indicator. Electric and pneumatic control from simplest to most complex types. Multi-point monitoring or recording of 2 to 400 separate inputs.

...Let your application decide



The Special Class 14 Line of *ElectroniK* instruments is calibrated to an accuracy of ±.5% of scale span . . . priced lower than the Precision line. Includes strip chart and circular chart recorders and recording controllers, also circular scale indicating controllers. Electric control of the contact, time-proportioning or position-proportioning type is available.



Millivoltmeter Instruments give dependable and accurate service, at low cost. High-resistance galvanometer circuit minimizes effects of varying length of extension wires. Plug-in unit design speeds servicing. *Pyr-O-Vane* controllers, in either horizontal or vertical case, give snap-action electronic vane control or pulse-type time-proportioning control.

which Honeywell instrument

fits your needs

Got a temperature measurement or control job to handle? There's no need to "shop around." For from *one* source—Honeywell—you can be sure of getting exactly the right instrument to fit your needs.

This is the time-saving—and money-saving—way to choose instruments. You can choose from the most complete, most diversified line of pyrometric instruments on the market. Your selection can hit the application right on the button—giving you the performance you need at the price that fits your budget.

For the peak in precision and versatility, there's the "Precision" *ElectroniK* line. This is the pioneer "continuous balance" electronic instrument that thousands of plants and laboratories have used for many years. It's available in eleven basic models, and can provide automatic control action from the simplest to the most advanced types.

For less exacting applications, a new series of instruments—the "Special" *ElectroniK* line—is now available. They provide many of the forms of automatic control you can get with the "Precision" line. And they cost less . . . bringing *ElectroniK* performance within the reach of even wider areas of application.

For simplified indicating control, Honeywell offers a line of economical millivoltmeter instruments . . . *Pyr-O-Vane* controllers, with a variety of electric control forms . . . and *Protect-O-Vane* controllers for excess temperature safety cut-off.

Your local Honeywell engineer will be glad to help you determine which type of instrument best fits the needs of your own application.

Call him today . . . he's as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

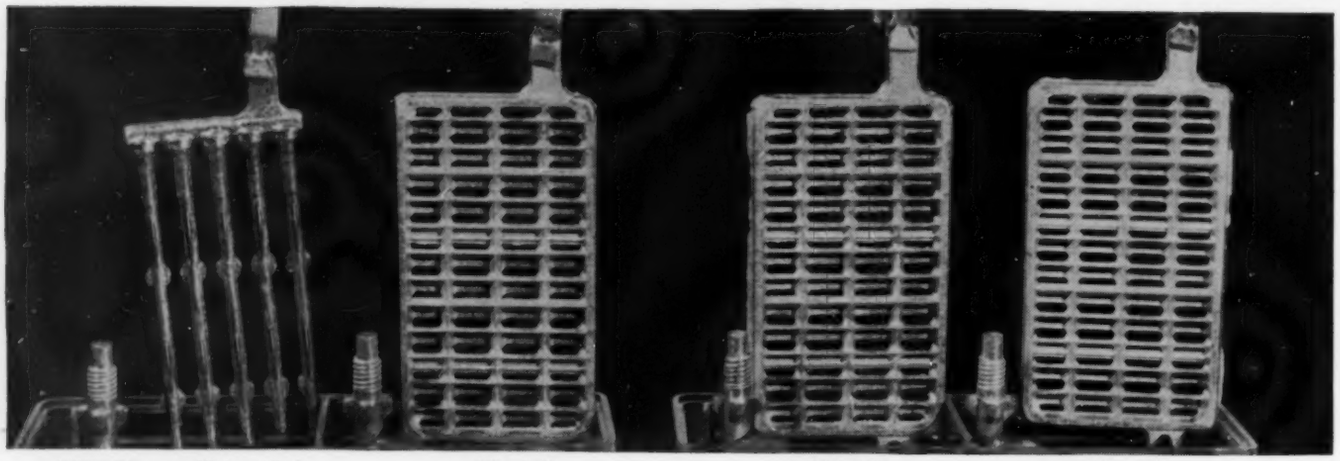
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

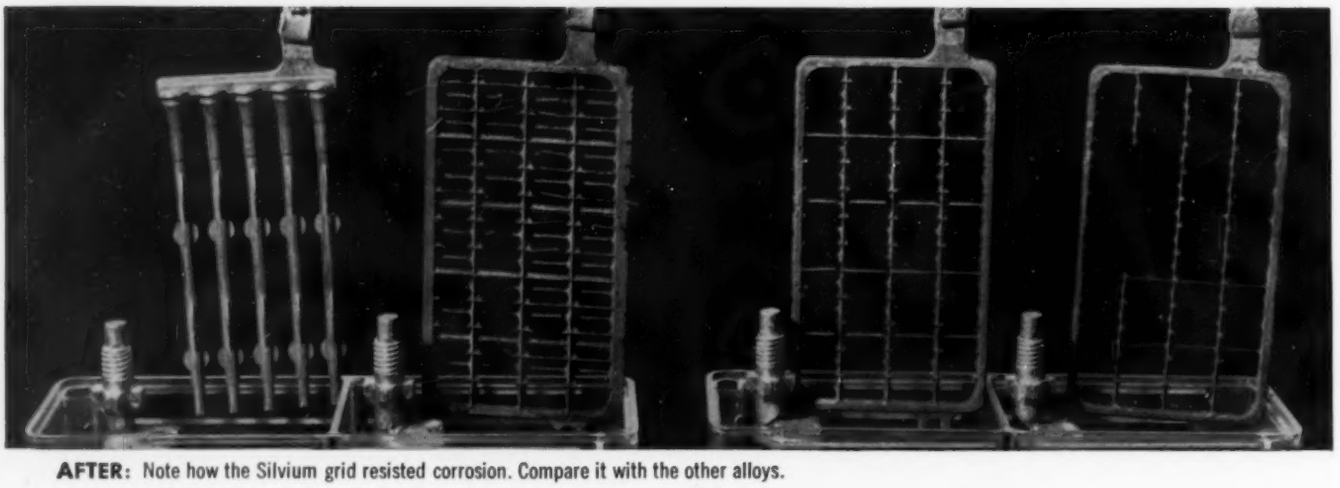
First in Controls

EXIDE-IRONCLAD BATTERIES

For electric industrial truck operation



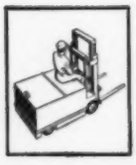
BEFORE: Silvium alloy — Alloy "A" — Alloy "B" — Alloy "C"



AFTER: Note how the Silvium grid resisted corrosion. Compare it with the other alloys.

Corrosion resistant SILVIUM prolongs battery life

BATTERY FOR ELECTRIC INDUSTRIAL TRUCK, Model TH. Fits snugly into space provided on truck. Has tubular construction of positive plates, Silvium grids, "Permanized" negative plates, extra heavy connectors and all other Exide-Ironclad advantages that mean power to spare in heavy duty applications. Write for Bulletin 5161.



Reaching down deep into every Exide-Ironclad Battery are the fingers of Silvium alloy metal which form the grids of the famous Exide-Ironclad positive plates.

Silvium is a special alloy developed by Exide to resist corrosion and thus prolong battery life. For proof, Exide research engineers compared the performance of an Ironclad Silvium grid side by side with ordinary grids of other lead alloys. As the photographs above show, only Silvium came through the test without damaging corrosion—undiminished in size, unimpaired in strength. The other grids showed from moderate to severe corrosion.

Tests have proved that Silvium is not only more resistant to corrosion, but also a better conductor of electricity. Hence it both prolongs battery life and —because there's less internal battery resistance—more readily permits heavy drafts of power.

This special material is only one of the many exclusive features which have made Exide-Ironclad Batteries world famous for high capacity and long life. When you order batteries for heavy duty applications, or the equipment requiring such batteries, be sure to specify Exide-Ironclad. Write for detailed bulletin. Exide Industrial Division, The Electric Storage Battery Company, Phila. 2, Pa.

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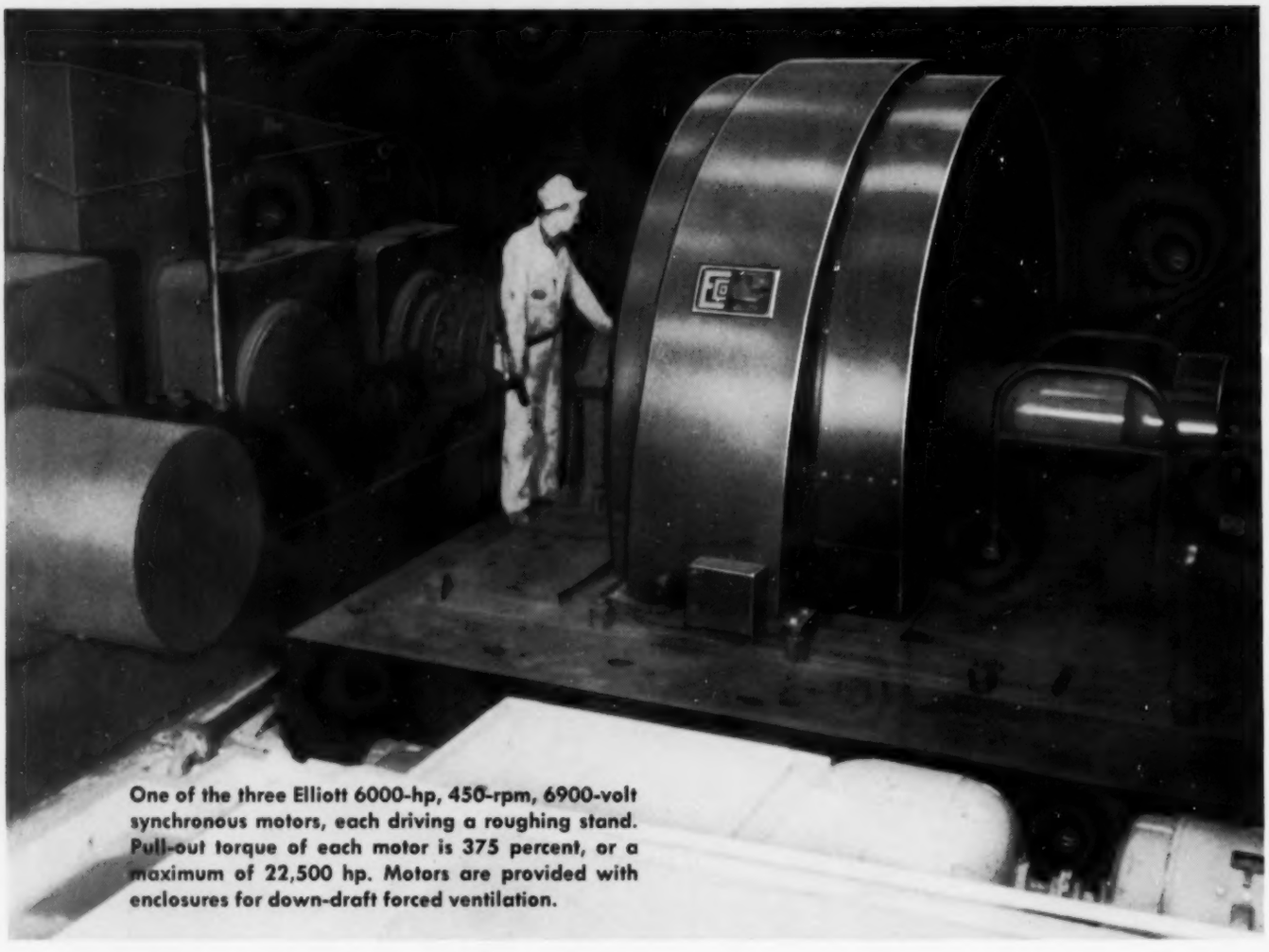

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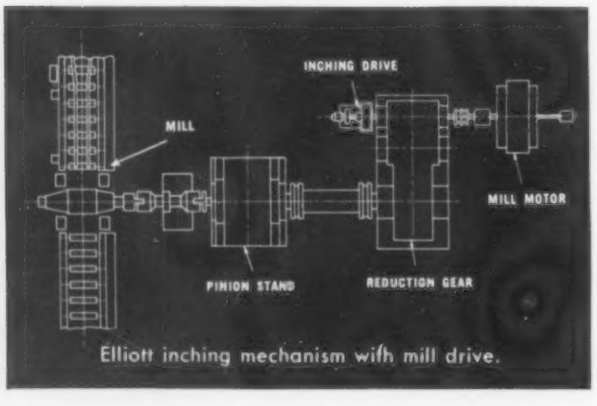

Elliott inching mechanism with mill drive.

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Pumping Progress Report

FOR MECHANICAL ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

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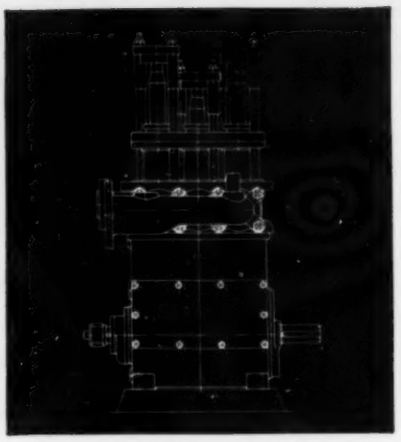

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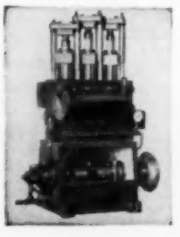

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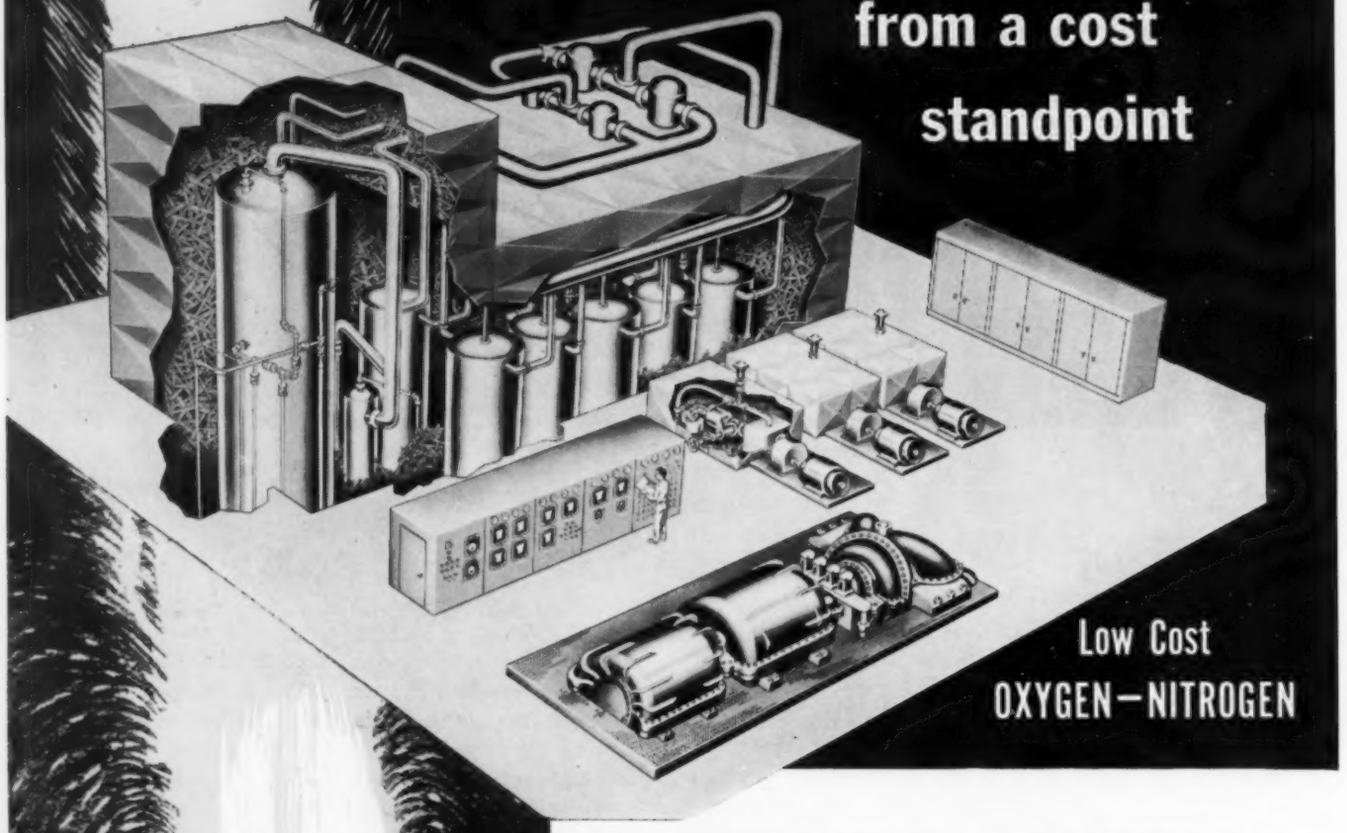

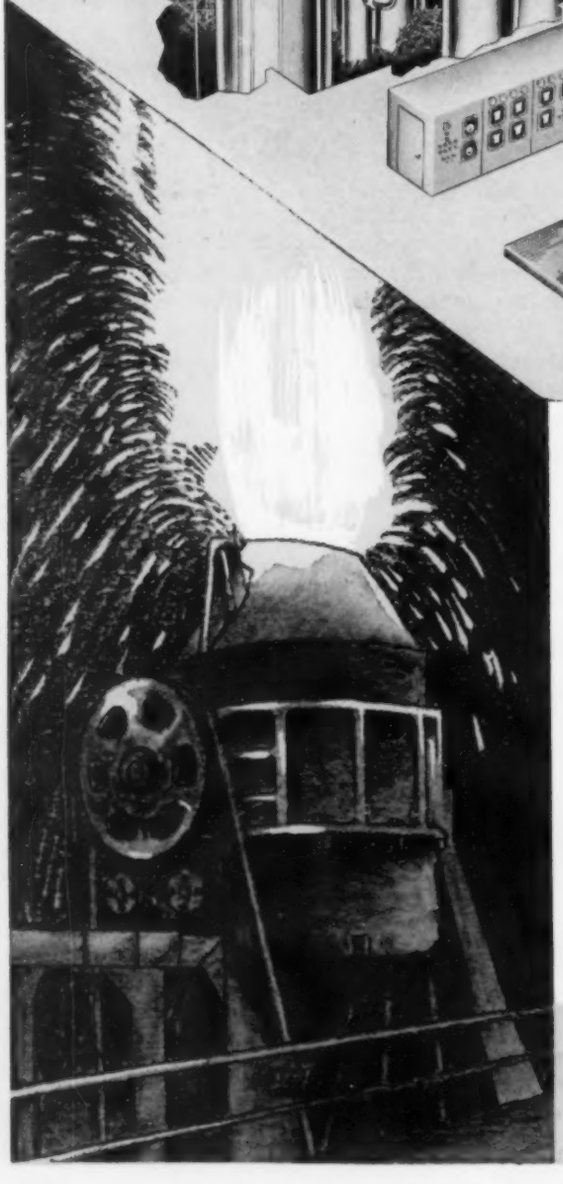

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By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period January 10, 1956 through January 31, 1956 . . . .

STRIP WIDTH GAGE

▲ U.S. 2,730,006, issued Jan. 10, 1956 to Paul P. Gottschall and assigned to United States Steel Corp., describes a device for determining the width of a steel strip traveling through a processing line such as a continuous pickler.

As shown in Figure 1, a pointer 16 mounted on a carriage 6 cooperates with a stationary scale 14, indicating approximately the width of the strip S. A light source 18 is mounted on each carriage 6 below the path of travel of the strip. A pair of cylindrical lenses (not shown) are mounted on each of the carriages 6 between the light source 18 and the strip S. A photovoltaic cell 24 is mounted on each carriage above the edge of the strip. An adjusting rheostat 32 is arranged in series with the light sources 18. A balancing rheostat 34 is connected across the light sources 18. The photovoltaic cells 24 are connected in parallel to a microammeter 36.

With no strip in the device, the rheostat 32 is set so that microammeter 36 reads full scale. One light source is then covered and the balancing rheostat 34 adjusted so that the ammeter reads zero center. The other light source is then covered and the first light source uncovered, and the microammeter should again read zero center. The handle 54 is then turned until the pointer 16 is opposite the desired width on the scale 14. If the strip S is of the width indicated on scale 14, the amount of light appearing on the photovoltaic cells will have an area equal to the area of one cell (as seen from the location of the light sources 18 in the Figure). This will give a zero reading on the ammeter, in which case a light 48 is on. In case the strip passing through the gage is over width, it blocks more light. The ammeter therefore reads a value which is calibrated in inches. The electric circuit is so arranged that light 48 goes out and light 50 goes on. Similarly, if the strip is less than standard width, more light falls on the photovoltaic cells, an opposite reading on the microammeter is obtained, light 48 is out, and light 46 goes on.

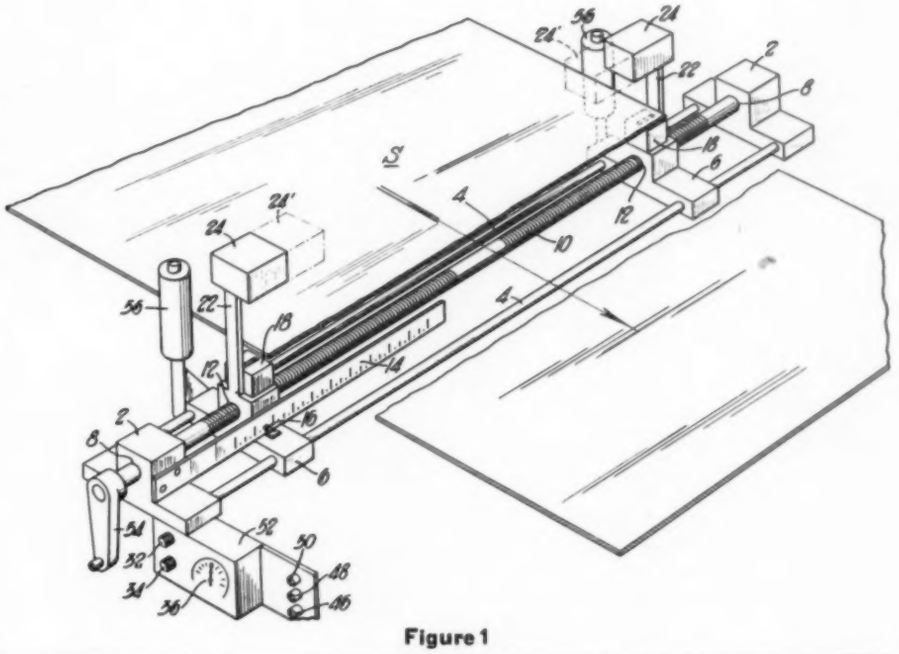


Figure 1

EDGE SCANNER FOR STEEL STRIP

U.S. 2,730,348, issued Jan. 10, 1956 to George H. Rendel and assigned to

United States Steel Corp., describes a scanner for detecting cracked edges or similar flaws in the edges of a steel strip prior to annealing the strip.

A light source is placed over the strip and a photocell 32 below. When a defect occurs in either edge of the strip, light from the source strikes the photocell, causing an alarm to sound, and also stopping the motion of the strip through the annealing line.

DEPHOSPHORIZING AND REFINING BESSEMER STEELS

U.S. 2,730,442, issued Jan. 10, 1956 to Arthur Thill, describes a method for dephosphorizing, refining, and desulphurizing Thomas or Bessemer steels by the use of $Na_2CO_3 \cdot 10H_2O$. This material can be added to molten metal without danger. The superheated steam which is liberated from the water of crystallization oxidizes the phosphorus. The phosphate thus formed enters into combination with the alkaline oxide produced by the

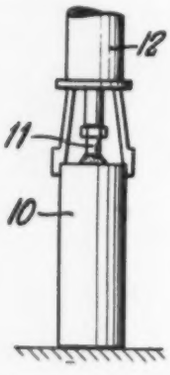


Figure 2

decomposition of the sodium carbonate.

The alkali phosphate thus formed has a very high stability at high temperatures. Sulphur is also partly removed in the process, and gases are very largely removed by the intense agitation caused by the chemical reaction.

According to the inventor, the cost is about 20 cents per ton of steel. The phosphorus content is 0.015-0.025 per cent, and the sulphur content is reduced by about 25 per cent. It is also claimed that the steel is extremely clean and sound.

HOT-WORKING STEEL BILLETS

U.S. 2,731,145, issued Jan. 17, 1956 to Andrew F. Kritscher and assigned to United States Steel Corp., relates to the heating of steel billets for hot-working by extrusion or forging.

A billet 10 has a low-carbon steel stud 11 welded to one end, as shown in Figure 2, by means of a welding device 12. The billet is then hung on a supporting hook 13 suspended from a conveyor trolley. Before being carried through a furnace 14 of the radiant panel type, heated by radiant burners 15 as shown in Figures 3 and 4, the billet is coated with a slip of glass frit and clay in water. This seals the billet from contact with oxidizing furnace gases, since the coating fuses at the furnace.

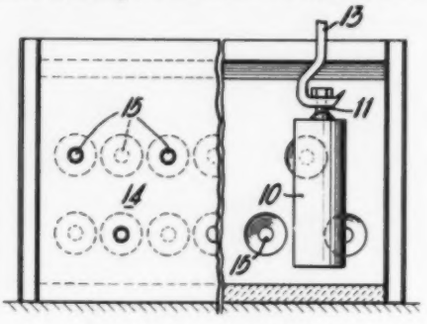


Figure 3

Heating is accomplished very rapidly (about 4-5 minutes per inch of billet diameter), thereby further minimizing oxidation of the steel.

A cylindrical shield 16 of thermal insulation may be provided for the supporting stud 11, as shown in Figure 5.

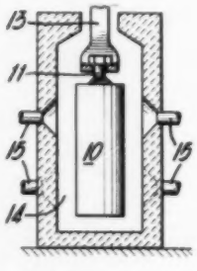


Figure 4

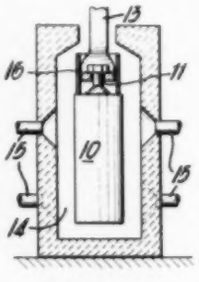


Figure 5

When the billet is chilled by air, the surface of the coating becomes highly abrasive. It is therefore fluxed with borax lime, or barium chloride, which may be dusted or blown on. This converts any abrasive residue on the billet into liquid form; thereby preventing the formation of a pit or pock mark on the billet.

The stud is then severed by shears, as shown in Figure 6. The coating remaining on the billet is effective as a lubricant during hot-working.

After forging or extrusion, the product is cooled in air or is water quenched, causing some of the glassy film left on it to flake off, removing also whatever scale has dissolved in it. A light pickle then leaves a good finish on the surface.

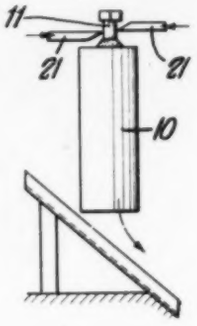


Figure 6

METHOD FOR THREADING STRIP THROUGH A CONTINUOUS STRIP PROCESSING LINE

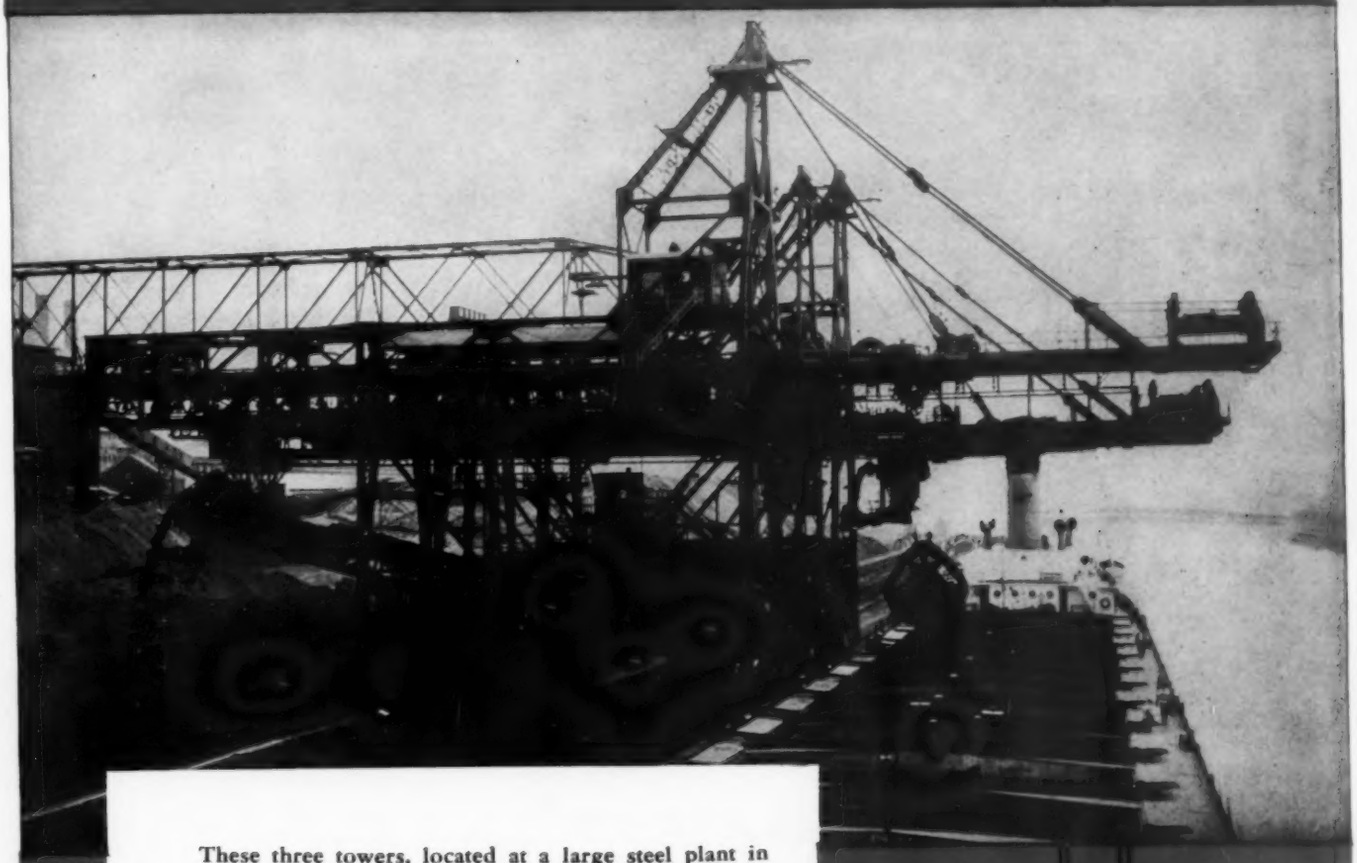
U.S. 2,731,262, issued Jan. 17, 1956 to Harry C. Morrow and assigned to United States Steel Corp., describes a method of threading strip which has broken in the processing equipment without dumping the cleaning solution from the tank.

As shown in Figure 7, strip S passes from the uncoiler 56 over roll 58 and through tank 2. In case of strip breakage, the free end S of the strip already in line is jogged ahead by operation of the driven roll 16 to a point adjacent the roll 12. The other broken end S_2 of the strip is jogged backward by operation of the coiler 56 to a point adjacent the roll 8 where an eye-loop is made on the end of the strip as shown in Figure 8. A threading bar 48 is inserted through the eye and fastened at each end to attachments on the chain (described in the patent but not shown here). The chains 18 are then rotated by operation of a motor in a forward direction and the end S_2 is pulled up through the solution around the roll 10 until it reaches a point close to the end S_1, as shown in Figure 9. The eye is cut off, the threading bar 48 removed, and the two loose ends of the strip welded together after which the line is put back into operation.

MANUFACTURE OF NICKEL-PLATED STEEL

U.S. 2,731,403, issued Jan. 17, 1956 to Michael M. Rubin and assigned

UNLOADERS and BRIDGES
for Ore...Limestone...Coal



These three towers, located at a large steel plant in Detroit, provide an impressive illustration of the effective design and sturdy construction of Mead-Morrison equipment. The latest addition to this team of unloaders, the tower in the foreground, is provided with a rotating bucket and a belt conveyor which carries ore from hopper back to trough, making possible an unloading rate of 2000 tons per hour.

From the trough, the ore and limestone is rehandled by Mead-Morrison bridges to the storage pile and the high line feeding the blast furnaces.

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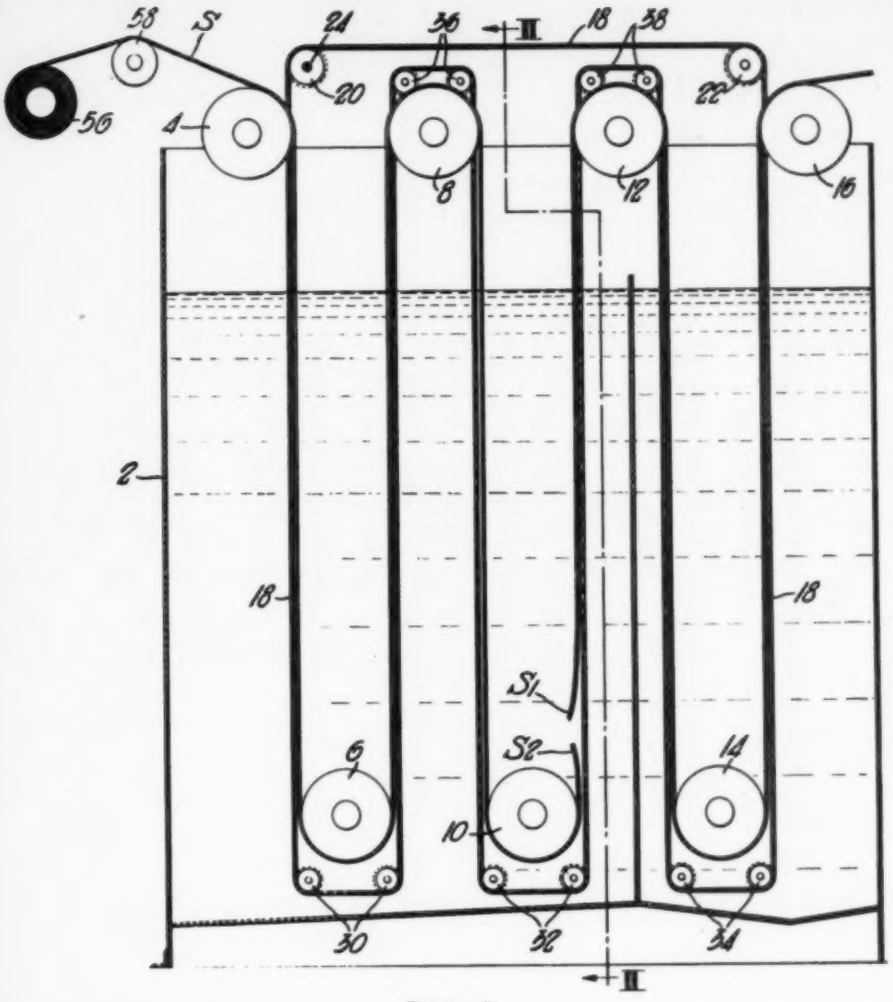


Figure 7

to Pittsburgh Steel Co., describes a process for nickel plating hardenable steels and alloy steel rolled and drawn products.

It is known that an improved bond

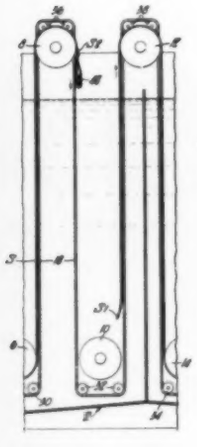


Figure 8

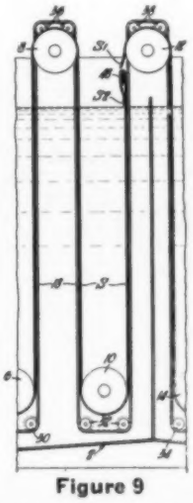


Figure 9

can be obtained between the nickel coating and the steel by an annealing operation. At the same time, the steel (containing not more than 0.20 per cent carbon) is itself annealed. In the present invention, hardenable steels and alloy steels, such as spring steels, are plated with nickel and then subjected to heating to 1450-1650 F followed by quenching and tempering. This heat treatment improves the bond between the nickel and the steel, and at the same time hardens the steel. The results are better than can be obtained by nickel plating previously tempered steel.

RECOVERING MANGANESE FROM BASIC OPEN-HEARTH SLAGS

U.S. 2,732,293, issued Jan. 24, 1956 to Rene Perrin and assigned to Societe d' Electro-Chimie d' Electro-Metallurgie et des Acieries Electriques d' Ugine, describes a process for recovering manganese from basic open-hearth slags.

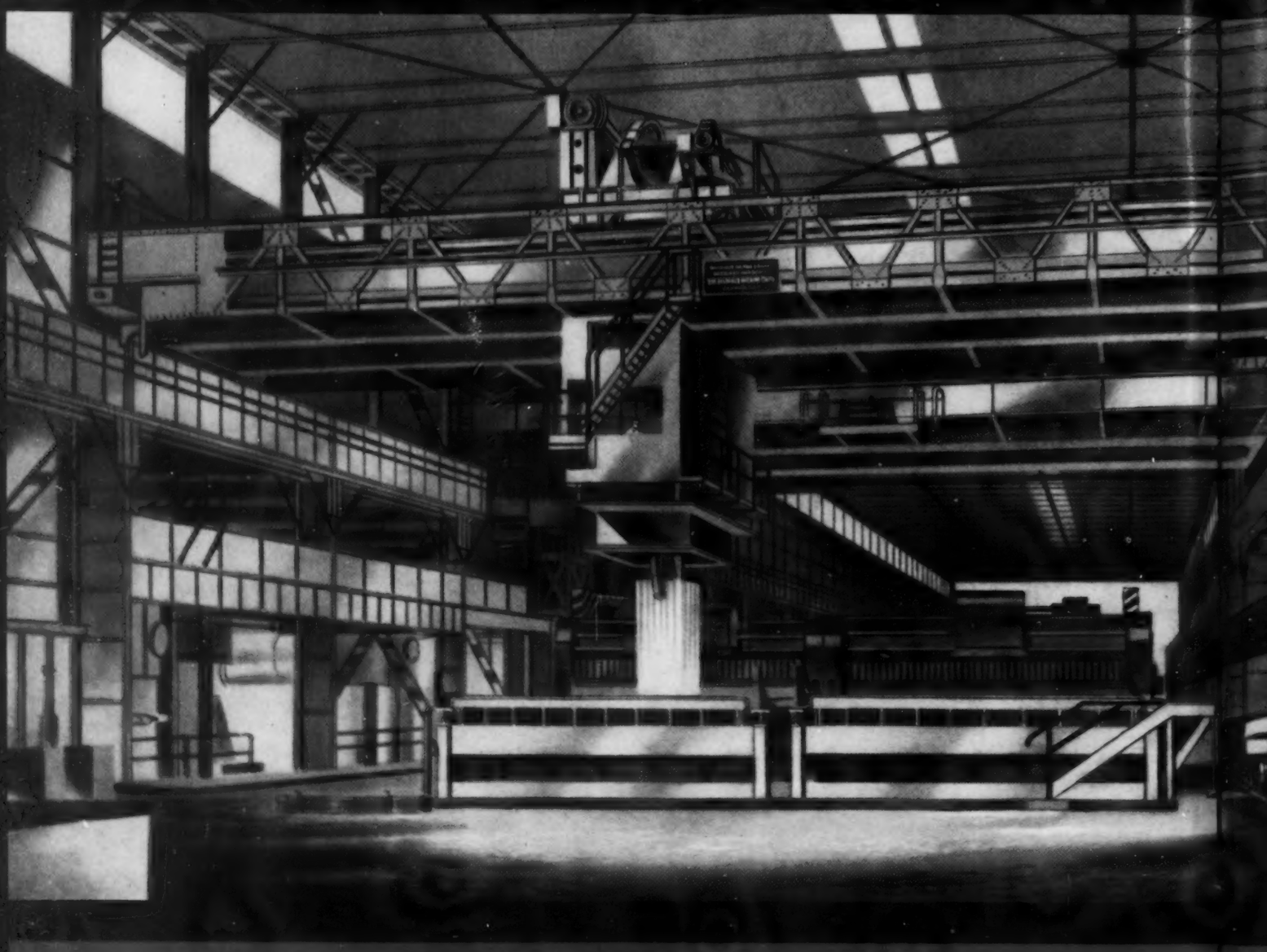
The slag is first converted into an acid slag by introducing silica into it in an electric furnace. The slag is then partially reduced by adding carbon, until the iron content of the slag is lowered to 5 to 10 per cent. A metallic bath forms under the acid slag, consisting of the reduced iron with very little manganese, but nearly all the phosphorus and sulphur originally contained in the slag. The manganese stays in the slag because of the slag's acid nature, despite the reduction.

The refined slag may now be used as a raw material for the recovery of manganese in a form suitable for metallurgical use, or the slag may be used directly in an open-hearth furnace.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,730,048-9	1/10/56	Car truck	American Steel Foundries
2,730,233	1/10/56	Apparatus for inspecting and classifying flat steel products	United States Steel Corp.
2,730,352	1/10/56	Ceramic fan construction for heat treating furnaces	Harold N. Ipsen
2,730,441	1/10/56	Reduction of iron formate	Republic Steel Corp.
2,730,641	1/10/56	Magnetic compensator	United States Steel Corp.
2,730,707	1/10/56	Signalling device for synchronously controlling coke guide and pusher machines of a coke oven battery	Koppers Co., Inc.
2,731,212	1/17/56	Polyphase electromagnet strip guiding and tension device	Richard S. Baker
2,731,327	1/17/56	Hydrometallurgical treatment of titaniferous iron material	National Lead Co.
2,731,690	1/24/56	Manufacture of centrifugally cast pipe	American Cast Iron Pipe Co.
2,731,878	1/24/56	Determination of the microconstituents in metals	United States Steel Corp.
2,732,066	1/24/56	Mandrel cooling for extrusion presses	Hydropress, Inc.
2,732,323	1/24/56	Welding and heat treating stainless steel	Armco Steel Corp.
2,732,601	1/31/56	Continuous casting of steel	Siegfried Junghans
2,733,023	1/31/56	Reel for coiling strip	Republic Steel Corp.
2,733,137	1/31/56	Fluidization and suspension roasting of iron sulphide ores	Allied Chemical & Dye Corp.
2,733,141	1/31/56	Pneumatic process for the refining of basic pig iron	United States Steel Corp.
2,733,197	1/31/56	Coke ovens	Jean H. F. Cassan
2,733,199	1/31/56	Electrolytic treatment of metal surfaces	Bethlehem Steel Co.

INTENSIFIED GRIP...



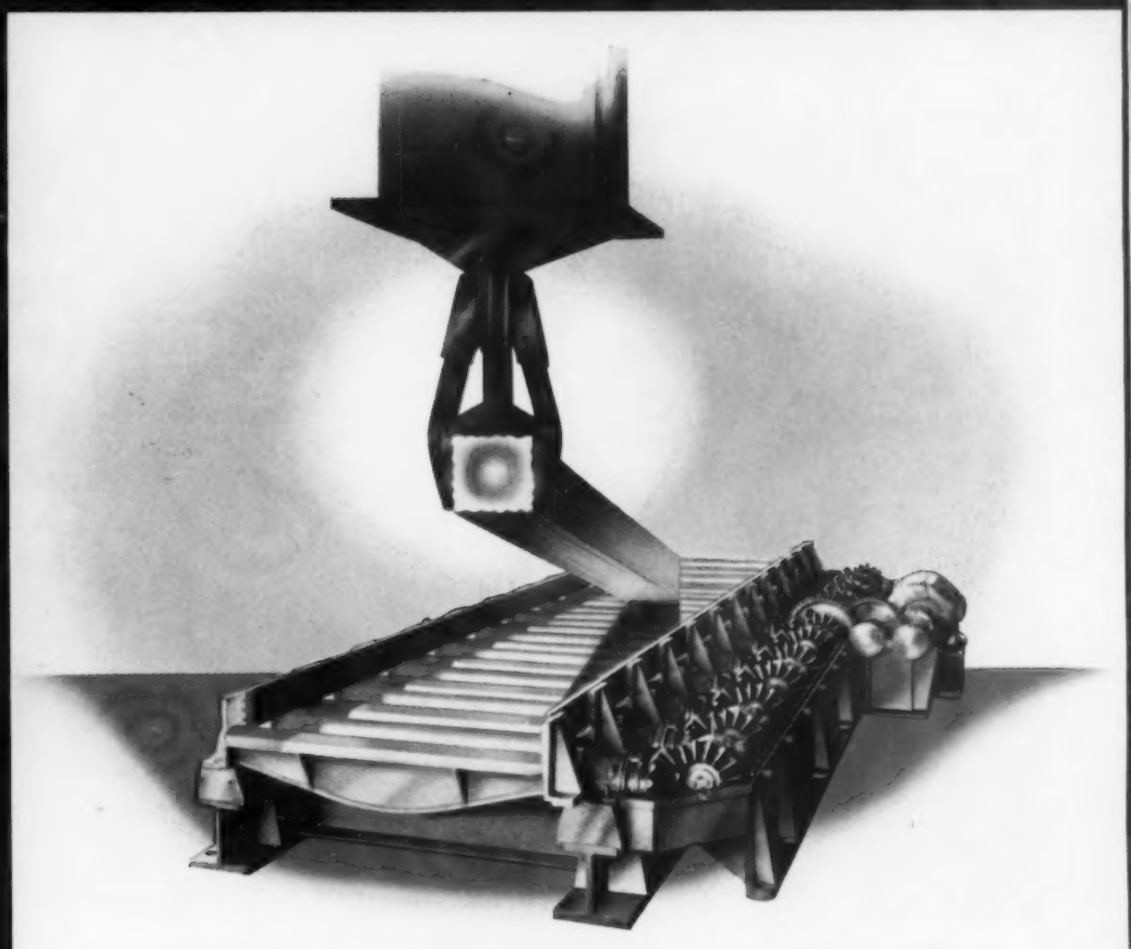
The tong grip of the conventional soaking pit crane depends *solely* on the weight of the ingot and when the weight of the ingot is removed, as in the case of placing an ingot on an approach mill table, the grip is reduced to zero and the ingot drops.

The tongs' grip of the Alliance intensified grip soaking pit crane is produced by the weight of the column *plus* the weight of the ingot. Since the weight of the column is usually equal to the weight of the ingot, the intensified grip soaking pit crane has the same grip *without* an ingot in the tongs as a conventional soaking pit crane has with an ingot, and *twice as much grip* as the conventional soaking pit crane when handling an ingot.

These intensified grip soaking pit cranes are built to handle ingots of any size and weight and incorporate all modern safety features. We welcome the opportunity to assist in solving your material-handling problems.

THE ALLIANCE MACHINE COMPANY

for Soaking Pit Cranes



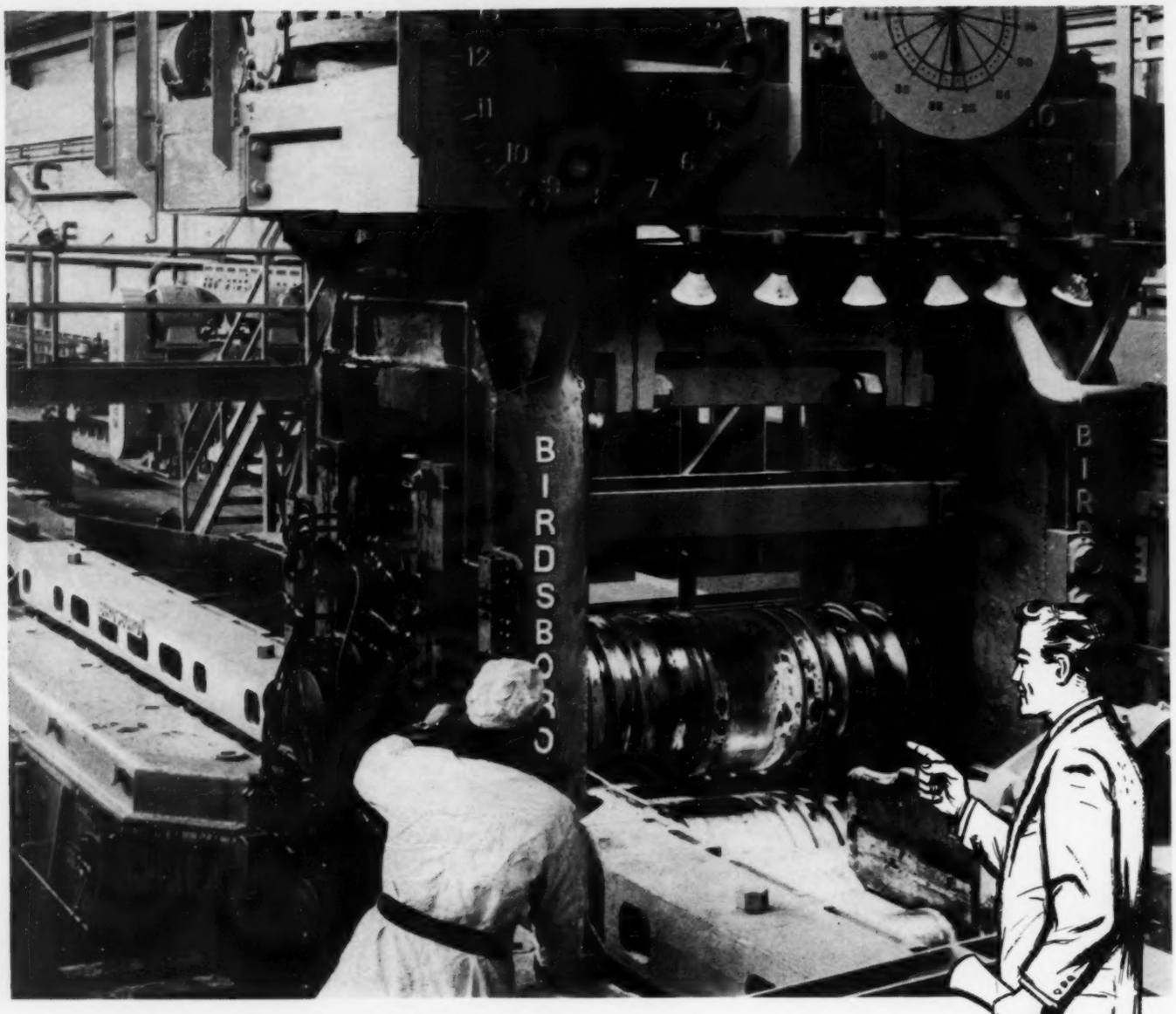
The intensified grip soaking pit crane was developed by The Alliance Machine Company to hold ingots more firmly in the tongs and prevent dropping of ingots when they are placed on the mill approach table, ingot chariot or in the soaking pits. This is an exclusive Alliance feature.

Alliance

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

MAIN OFFICE • ALLIANCE, OHIO

THE WORLD'S LARGEST BUILDER OF THE WORLD'S LARGEST CRANES



The BIRDSBORO Roll Specialist is a man who knows mills...

. . . and he's well-schooled in helping to handle problems for mill operators across the nation. His job involves much more than selling . . . it's a *service* job, a job that calls for helping you get more tonnage and a better product. But one of the things that makes his work easier is this: He has an exceptionally fine line of rolls to work with . . .

IRON BASE ROLLS: Grainloy, Birdsboro Metal, Curoloy Superloy, Super Curoloy.

STEEL BASE ROLLS: Diamondite, Birdsboro Special, Birdsboro "30", "40", "50", and "75".

Designers and Builders of:
STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

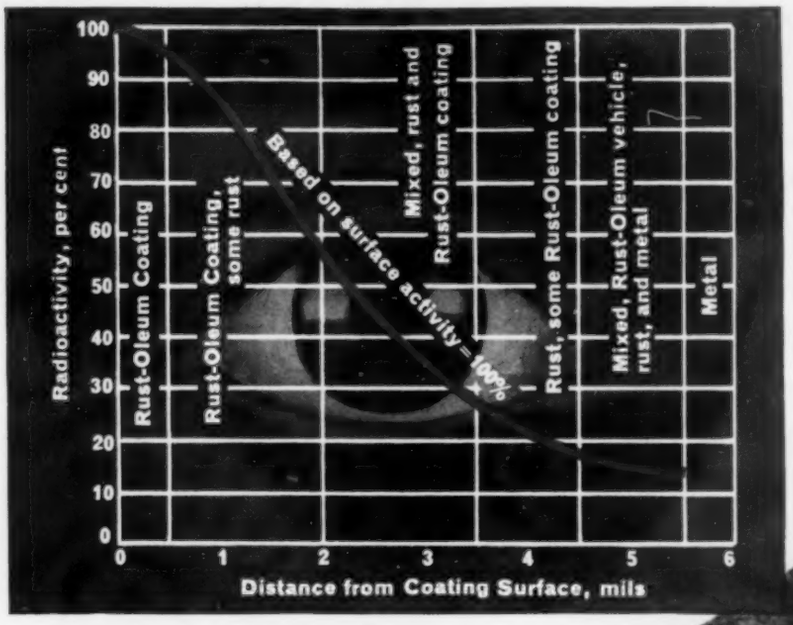
R-17-56

BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., Main Offices in Birdsboro, Pa. District Office: Pittsburgh, Pa.

New York Office: **Engineering Supervision Co.,** *743 Fifth Ave., New York 22, N.Y.*

See Rust-Oleum *penetrate* *rust* to bare metal through the "Eyes" of Radioactivity!



Curved line illustrates Rust-Oleum penetration through rust at each mil level as recorded by Geiger Counter.

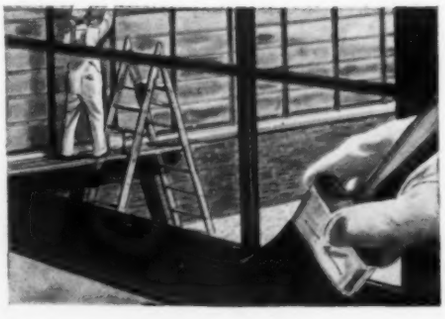
Rust-Oleum dries to a firm, decorative coating that resists salt water, sun, fumes, heat, humidity, and weathering.

Geiger Counter traces Rust-Oleum penetration to bare metal! In nearly three years of radioactive research, Rust-Oleum's *specially-processed* fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer – then applied to rusted test panels. Rust-Oleum's specially-processed fish oil vehicle was then traced through the rust to bare metal by Geiger Counter.

This penetration means rust-stopping power, because the fish oil vehicle works its way into the tiny pits in the metal where it drives out air and moisture that cause rust. Important savings are yours, because Rust-Oleum can be applied directly over sound rusted surfaces – usually eliminating costly surface preparations. Attach coupon to your business letterhead for your copy of the thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists. Prompt delivery of Rust-Oleum is assured from your nearby industrial distributor.

There is only one Rust-Oleum. It is distinctive as your own fingerprint.

RUST-OLEUM®



STOPS RUST!

Rust-Oleum is available in practically all colors, including aluminum and white. See our complete catalog in Sweets, or write for information.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Rust-Oleum Corporation
2444 Oakton Street
Evanston, Ill.

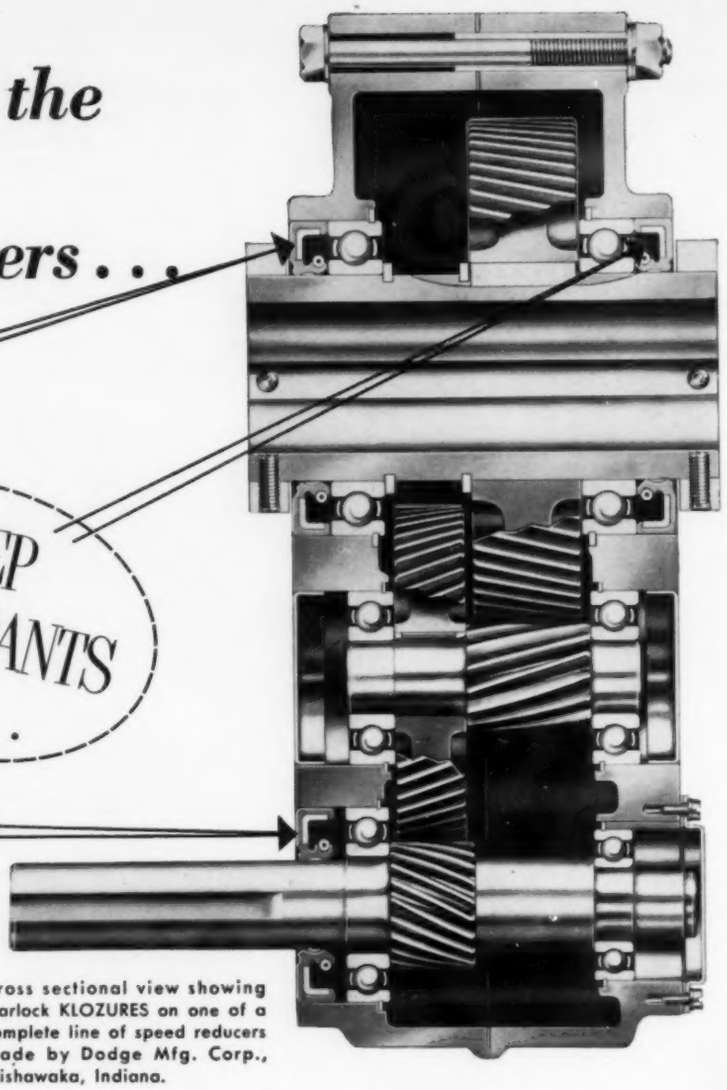
- ☐ Complete literature with color charts.
- ☐ Thirty-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

Over half the speed reducer manufacturers . . .

KEEP DIRT OUT . . .

KEEP LUBRICANTS IN . . .

WITH KLOZURE* Oil Seals



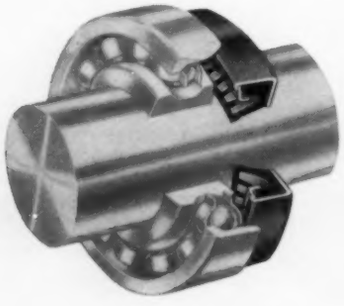
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

**Registered Trademark*



Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

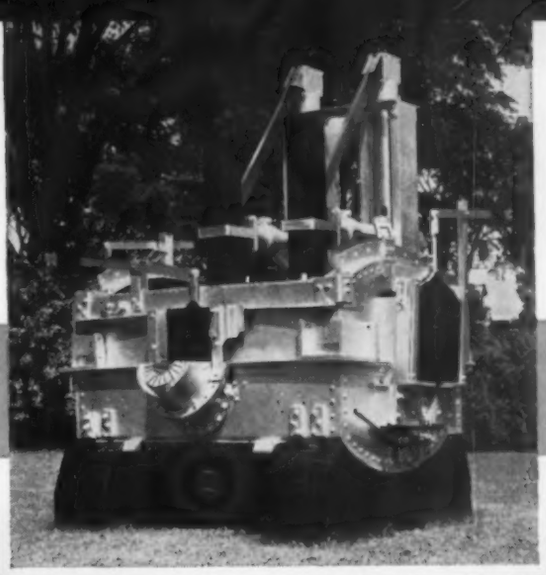
THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of the 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

INTRODUCED TO THIS COUNTRY in 1906 by the Halcomb Steel Company, the original American steelmaking furnace is now enshrined in a park on the grounds of Crucible Steel Company's Sanderson-Halcomb Works, Syracuse, N. Y. Installed and operated under the personal supervision of its inventor, the celebrated French scientist, Paul Louis Heroult, it was a three-ton, single-phase unit and the prototype of the modern Heroult electric furnace.



From France fifty years ago, came this

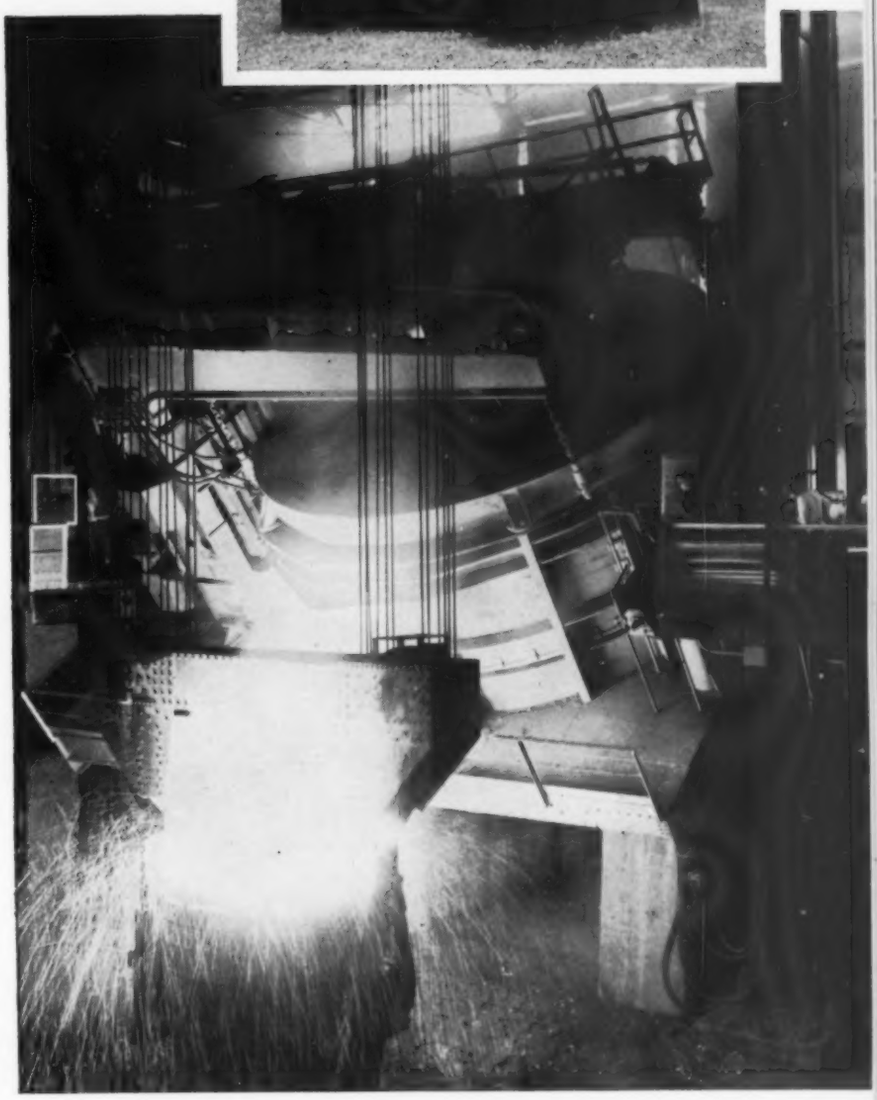
Faster, Cheaper Method of making High Quality Steels

The little Heroult shown above was the first electric melting furnace ever used in this country. Imported from France in 1906, it signalled the beginning of a new era of American steelmaking.

From the very beginning, the Heroult has been accepted as the most economical and best method of producing high quality special purpose steels; and today under certain conditions, large electric furnaces are competitive with open hearths.

Modern Heroult electric furnaces are available in sizes ranging in holding capacity from 6000 lbs. up to and in excess of 400,000 lbs. Both gantry and swing-type roof-removing mechanisms are available. Door-charging furnaces and furnaces of special design, including units equipped with austenitic steel bottoms to permit induction stirring, can also be supplied.

We welcome an opportunity to help you select and install the Heroult best suited to your requirements. Please remember, however, that because the Heroult is a precision-engineered unit made to your particular requirements, it is advisable to anticipate your future needs as far in advance as possible. *The Heroult we make and install for you will be the finest electric furnace that money can buy!*



ONE OF TWO 24'6" inside shell diameter Heroult electric melting furnaces installed in the ultra-modern mill of McLouth Steel Corporation in Detroit. These, the largest melting furnaces in the world, with transformer capacities in excess of 33,000 KVA, are capable of producing heats of more than 400,000 lbs. Featuring electro-mechanical controls throughout with swing-type roofs, they are equipped with the finest mechanisms and electrical apparatus available.

Heroult
ELECTRIC MELTING FURNACES

USS

AMERICAN BRIDGE DIVISION

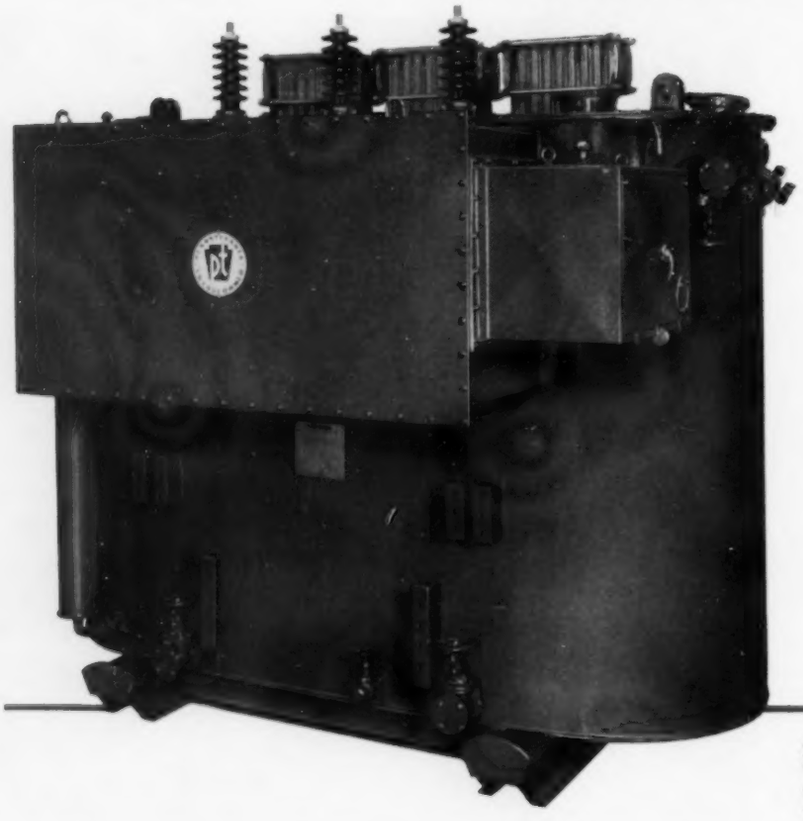
UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco, and other principal cities.
United States Steel Export Company, New York

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

Only 50 days from order to shipment !



20,000 kva Pennsylvania Furnace Transformer

20,000-kva Pennsylvania Furnace Transformer. Three phase, 60 cycles, water-cooled. High voltage: 24,000 volts. Low voltage: 375 to 250 volts.

The order was entered on Monday, December 19, 1955. 50 days later, on Tuesday, February 7, the finished transformer was loaded on a railroad car and sent on its way to the customer. Like most other furnace transformers, this one was custom-designed and custom-built to meet limiting dimensions. Accessories and auxiliary equipment had to be located on the high voltage side and ends of the tank. Low voltage bus work had to match existing facilities.

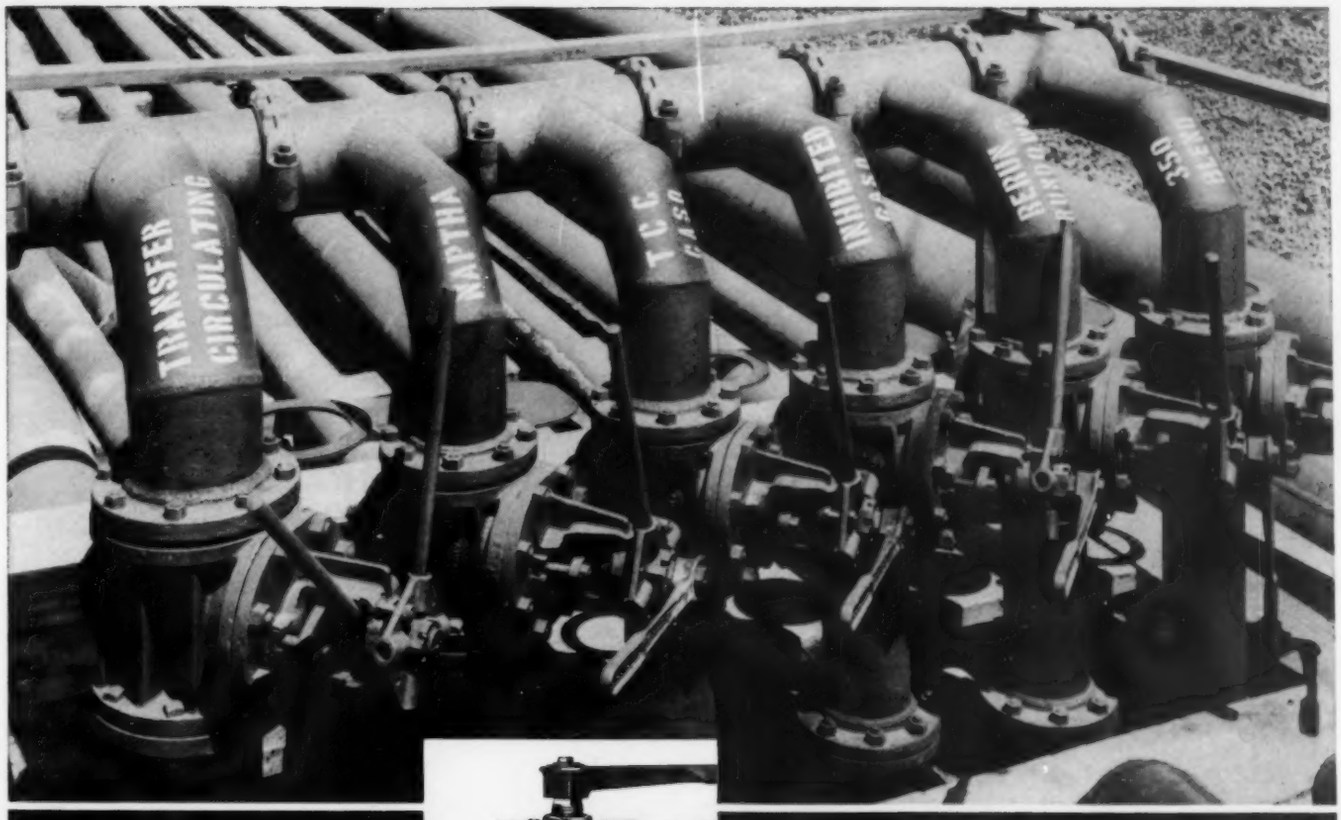
A 50-calendar-day delivery for a 20,000-kva furnace transformer is not an everyday requirement at Pennsylvania, but when circumstances demand it, deliveries such as this can be made.

Sixteen years ago, in 1940, Pennsylvania was called upon to design and deliver a 15,000-kva, 3-phase, 25-cycle furnace transformer in record time. A large transformer by today's standards, it was even more so a decade-and-a-half ago. Pennsylvania designed, built, and shipped that transformer in 35 calendar days and it is in active service today in a large steel mill.

Which all boils down to this:

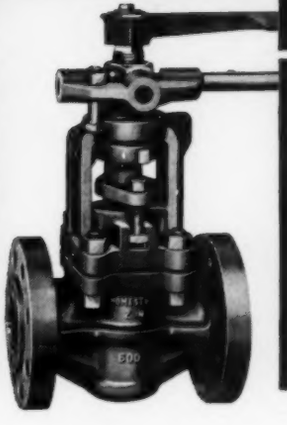
If you have a furnace transformer problem — whether it involves short-time delivery, special requirements, or unusual design problems — it will pay you to consult Pennsylvania.

PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division CANONSBURG, PA. Greater Pittsburgh District



if your problem is...

- TEMPERATURE
- PRESSURE
- CORROSION...



HOMESTEAD *Lever-Seald* **PLUG VALVES** *will solve it...*

Conditions which cause ordinary valves to fail --corrosive, erosive, viscous, or volatile hard-to-hold fluids, plus temperature or pressure extremes --are everyday jobs for Homestead Lever-Seald Valves. Why? Because they *are built to operate under all conditions!* They never stick!

Every Homestead Lever-Seald Plug Valve has a powerful lever and screw device that does double duty. It presses the tapered plug firmly into its seat to form a drop-tight seal, and also provides a positive means to relieve seating pressure and permit easy operation.

Lever-Seald Homestead Valves give extra long, leak-proof service, too, because all operating parts and seating surfaces are protected from line fluids in both the open and closed positions. You can prove their economy to your own satisfaction, by making your next replacement a Homestead Lever-Seald.

Your choice can be made from valves cast of metals and alloys to specification in sizes from 1″ to 12″; for pressures from vacuum to 1500 pounds; temperatures from 40° below zero to 1100°F. Dry seat or pressure gun lubricated optional.

You'll find our VALVE REFERENCE BOOK No. 39-3 interesting and helpful. It's yours for the asking.

MAIL THE COUPON TODAY!

Without obligation, send me Valve Reference Book No. 39-3 describing Homestead Lever-Seald Plug Valves.

Name_____ Title_____

Company_____

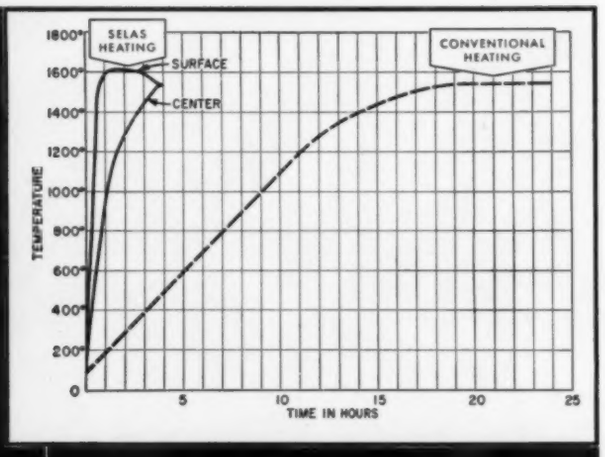
Address_____

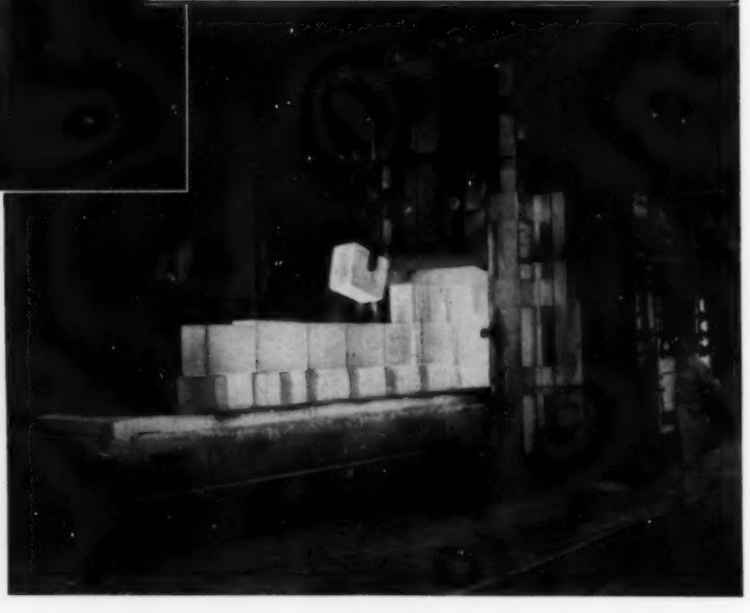
City_____ State_____

HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. BOX 21 *"Serving Since 1892"* CORAOPOLIS, PA.

FAST HEATING of LARGE STEEL SECTIONS is *practical* and *safe* with Selas Gradiation®





FAST heating is playing an increasingly important part in helping modern industry keep pace with today's high production requirements and exacting demands. In addition to the obvious increases in output, ***FAST*** heating opens the way to automatic, continuous processing of large steel sections.

FAST: At the Heppenstall Company, Pittsburgh, for example, alloy steel die blocks, 8″ to 24″ thick, are heated to 1550°F, for hardening, *five times faster* by Selas Gradiation than by conventional methods.

SAFE: Sonic testing of every Selas ***FAST***-heated die block proves its flawless quality, reproducible uniformity.

PRACTICAL: The completely automatic program control heating accomplished in the Selas gas-fired furnace proves ***FAST*** heating is a practical tool for modern steelmakers.

Consider these additional Selas advantages: Precision timing of the heating cycle permits close scheduling of other facilities and manpower. Less labor and lower labor skills are required. Fuel savings of 20%. Quick, economical start-up.

The above furnace was prefabricated by Selas and installed intact in the Heppenstall plant with little or no production interference.

In another installation, Selas Gradiation ***FAST*** Heating handles steel sections up to 10′ x 24′ x 3.3′ . . . weighing 192 tons . . . *five times faster* than by usual practices.

Write Dept. 46 for descriptive data and more information about Selas Gradiation ***FAST*** *Heating*

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

DRAVO

DESIGNERS *and* BUILDERS

BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
WHIRLER CRANES • FLOATING CRANES
DRAVO RAIL CLAMPS • BARGE SHIFTERS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES

25 tons in one bite!

This rugged ore unloader operates around-the-clock at Pennsylvania Railroad's Greenwich Point pier in Philadelphia. To handle the huge tonnage of incoming ore, the heavy-duty machine uses an adjustable voltage system for maximum horsepower output and fast handling cycles. For Pennsylvania Tidewater Dock Company pier operators, this machine provides fast, smooth handling and increased capacity. This performance led to the ordering of a second Dravo-built ore unloader six months after the first machine was installed.

Many other users save time and trouble with Dravo-designed and built heavy materials handling equipment. You'll find this equipment at work in steel plants, power plants and at other heavy materials transfer points.

You can learn about Dravo's complete line of trolleys, bridges, towers and other related equipment by writing for Bulletin #225. Better still, let us arrange for your visit to actual installations. Simply call us at Pittsburgh, Spalding 1-1200.

DRAVO
CORPORATION
Neville Island, Pittsburgh 25, Pennsylvania

Air Conditioning • Boiler and Power Plants • Crane Cab Conditioners • Docks • Industrial Foundations • Open Steel Flooring
Pump Houses and Intakes • Space Heaters • Water and Waste Treatment Plants • Towboats and Barges

GENERAL ELECTRIC ANNOUNCES . .
NEW Industrial
GENERAL ELECTRIC
DIRECT CURRENT MOTOR
VOLTS
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Direct-current Motor

KINAMATIC* a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation—Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

Accelerated Production—The new d-c Kinamatic motor will modernize your equipment, give it increased power, higher speeds, greater output capacity. With the quick-acting G-E Kinamatic motor, your machines will process a greater variety of products . . . faster . . . easier . . . and with less maintenance and spoilage.

More Powerful—By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

Engineering Help—Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 813-1

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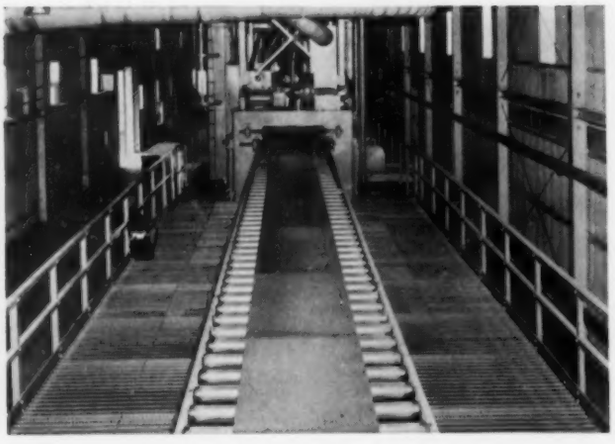
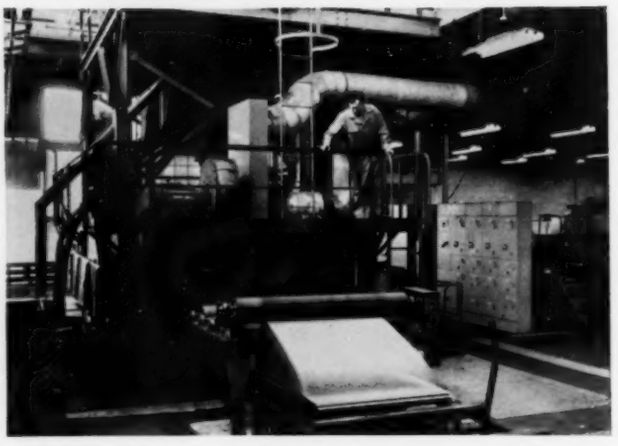
Progress Is Our Most Important Product

GENERAL ELECTRIC

How **WHEELABRATOR®** cleaning
CUTS STEEL COSTS

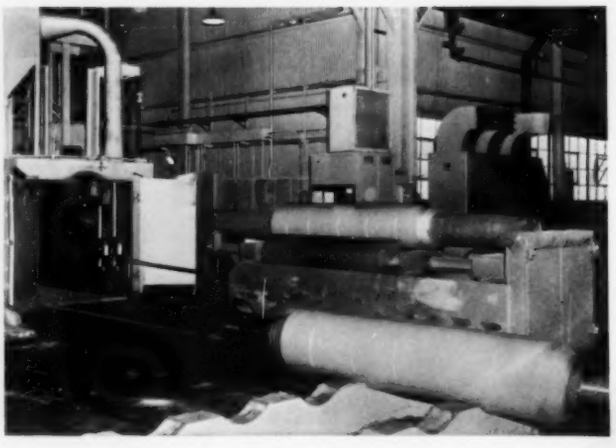


Cuts acid needs at least 75% in descaling continuous strip



Saves $4.00 to $7.00 a ton descaling sheet

Cleans slabs and billets for a fraction of a dollar per ton



Increases etched roll production tonnage 30%

Wheelabrator mechanical descaling offers impressive savings in lower production costs for steel producers and fabricators.

In descaling steel sheet or strip, Wheelabrating reduces or eliminates acid pickling; slashes labor costs, crane service and space requirements; improves product quality; adds to equipment life.

Wheelabrator leadership and experience in this field is demonstrated by the scores of installations now descaling slabs and billets, continuous carbon and alloy strip, sheet steel, bar stock, wire rod and structural steel shapes. Wheelabrators are also used to condition ingot molds and etch mill rolls.

Write today for complete information on a Wheelabrator airless blast cleaning machine that will meet your steel descaling requirements.

Mechanical cleaning saves in these 8 operations*

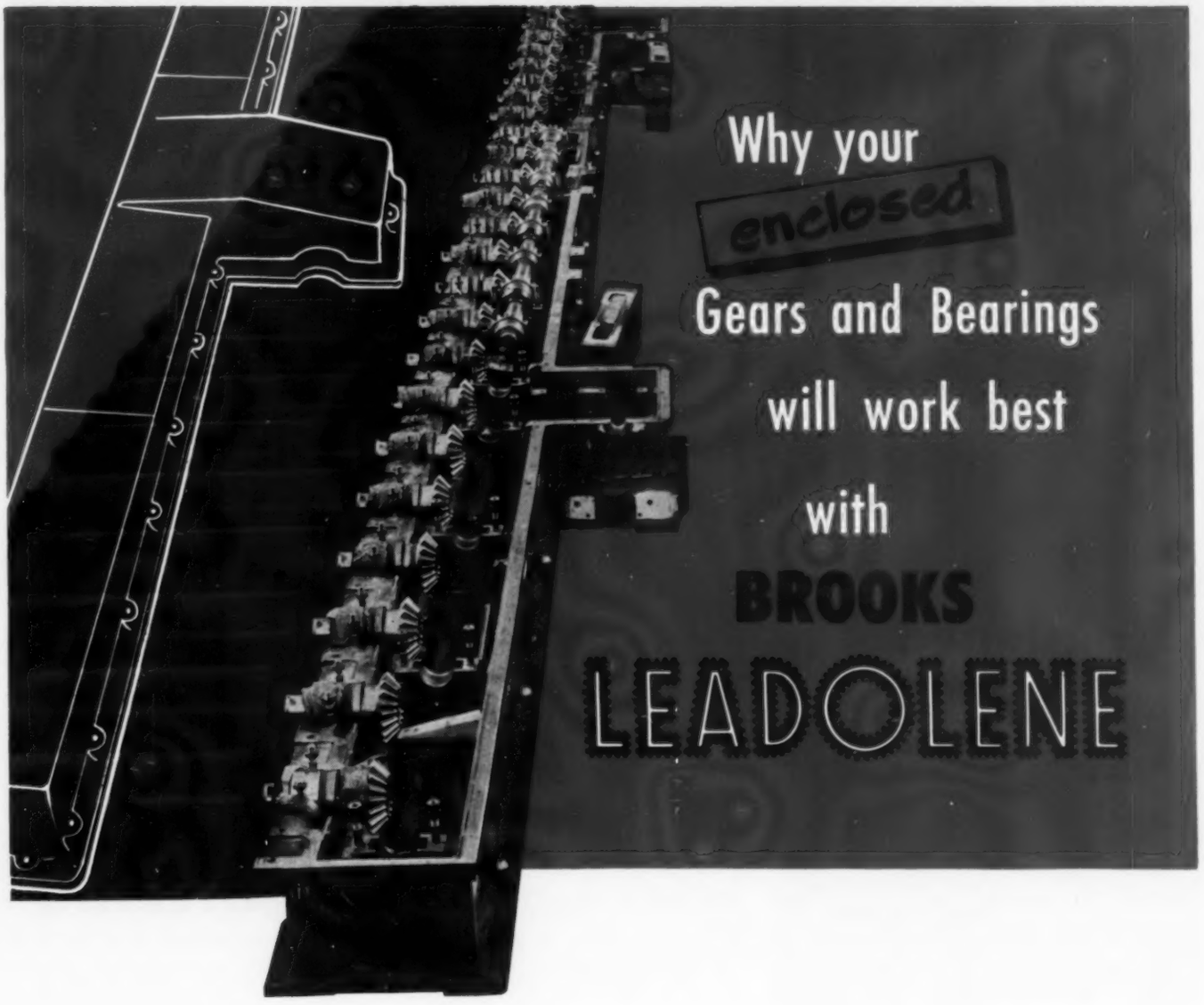
1. Continuous strip descaling
2. Sheet descaling
3. Steel shapes descaling
4. Bar stock descaling
5. Wire rod descaling
6. Mill roll etching
7. Slab and billet conditioning
8. Ingot mold conditioning

**Write for specialized literature*

WHEELABRATOR CORPORATION

World's Largest Builders of Airless Blast Equipment

WHEELABRATOR CORPORATION, 396 South Byrkit Street, Mishawaka, Indiana



Despite the severe conditions of water, mill scale, shock and backlash common in mill table applications . . . *Leadolene* can be counted on to extend gearing service while greatly reducing lubricant consumption. This extreme pressure, lead-base lubricant is not reduced in effectiveness by water. *Leadolene* in an enclosed gearing system is definite assurance against pitting, galling of teeth and abnormal bearing wear.

FOR SEMI-ENCLOSED GEARS . . . Various grades of *Leadolene* and *Klingfast* provide exceptional service in semi-enclosed gear applications. A Brooks engineer will assist you in selecting the correct type and grade.

FOR OPEN GEARS . . . *Klingfast,* with its "Indestructible pH-ilm" strength of 50,000 psi and extreme adhesiveness, is unequalled for service on open gears. Its efficiency is not reduced by water, and it is repellent to the adhesion of scale, metallics and other contamination.

Write for Technical Data on Brooks Lubricants
for Enclosed, Semi-Enclosed or Open Gear Service

With LEADOLENE you get these characteristics

pH-ilm Strength . . . 25,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion providing permanent coating on gears.

Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

THE BROOKS OIL CO.
Since 1876

Executive Offices and Plant . . . . . Cleveland, Ohio
Executive Sales Offices . . . . . Pittsburgh, Pa.
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Two large EF combination gas fired and electrically heated furnaces for uniformly annealing, normalizing, and galvanizing strip — continuously.

designed engineered and *Specially Built*

Part of an installation of large gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing strip.

for continuous and batch processing of ferrous and non-ferrous strip

We are in position to design, build and put into operation: continuous or batch type equipment for hot or cold rolled, high or low carbon steel, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous metal — for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process — in the size and type best suited to your plant, process, product or production requirements. No job is too large or too unusual.

Put your production furnace problems up to experienced engineers — it pays.

EF

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

This large EF combination electric and gas fired installation flame cleans, uniformly anneals and galvanizes strip continuously.

Check these machines now available from stock

LATHES

36″ x 19′ cc American Super Production, 40 HP, 230V, DC

42″ x 11′ cc Niles Geared Head Engine, 230 V, DC

48″ x 32′ cc American Super Production, 50 HP, 230 V, DC

54″ x 23′ cc N.B.P. Q.C.G. 230 V, DC

50″ Sellers Wheel, Late Type, Herringbone Gear Train

1-H Libby Turret, Chucking

3-R Gisholt Turret, Long Bed

4-R Gisholt, 9¼″ Hole

32″ x 12′ cc Niles Forge Turning

★ ★

BORING MACHINES

78″ Betts Fixed Rail, Late, Vertical

30″ x 48′ Niles "Timesaver" Boring

10′ Cincinnati Extra Height, Vert.

No. 4 LeBlond, Gun Boring, 36′ Bed

No. 420 Barnes, 2-Spindle Deep Hole

★ ★

GRINDERS

6″ x 18″ Cincinnati "ER" Plain

No. 3 Brown & Sharpe Universal

7′ Arm 19″ Col. Carlton Radial

4′ Arm 11″ Col. American, 1940

No. 2 Pratt & Whitney Jig Borer

16″ Ohio Heavy Duty Shaper

32″ Ohio Heavy Duty Shaper

25″ Jones Crank Slotter

16′ x 12′ x 40′ N.B.P. Planer, 4 Hds.

THE FIRST STEP in Simmons Engineered Rebuilding

Leading companies regularly send their machine tools to Simmons for rebuilding to original tolerances. Here's why:

First step of Simmons **Engineered Rebuilding** is the complete dismantling of the machine and sub-assemblies to base castings. Every part, every bearing, every surface is then examined and renewed or replaced, as necessary.

Simmons **up-dates** equipment to perform special jobs, **incorporates** modern features for higher speeds and closer tolerances than when the machine was new.

Savings are great. Unconditionally guaranteed **Engineered Rebuilding** is usually completed **at half the cost of a new tool!** Find out about the large savings available to you in initial cost, production, and maintenance through Simmons **Engineered Rebuilding**, and special-application machine design. Write or telephone today.

Send for new issue of THE SIMMONS WAY

New, illustrated case histories describe special drilling and boring machines, specially-designed flame-hardening equipment, and the rebuilding and modernization of various types of large machine tools. Send for your free copy.

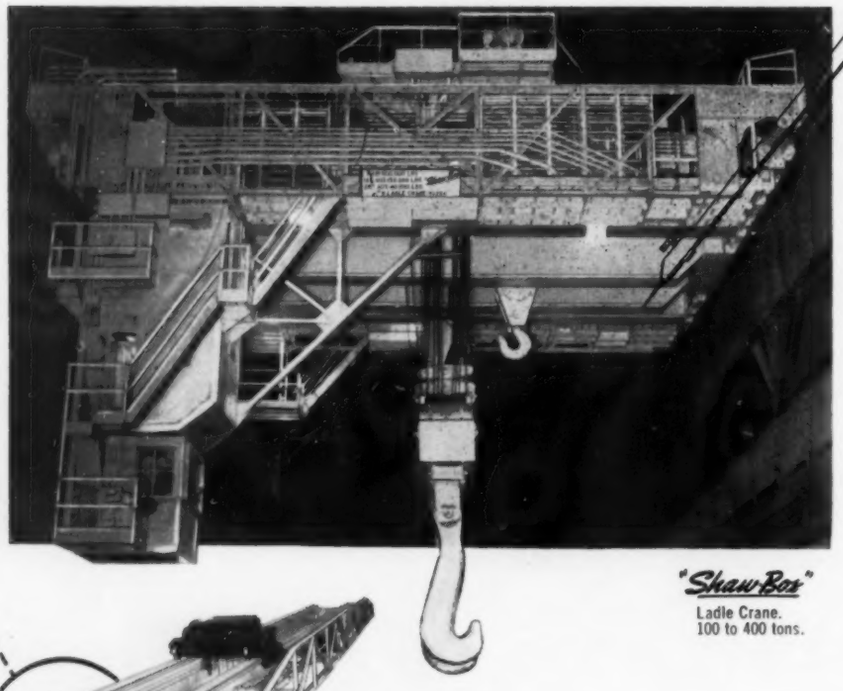
SIMMONS
ENGINEERED
Rebuilding
GIVES MACHINE TOOLS A NEW LEASE ON LIFE

Since 1910 . . . Builders and Rebuilders of unconditionally guaranteed machine tools

Simmons Machine Tool Corporation
1712 North Broadway, Albany 1, N.Y.
New York Office: 50 East 42nd Street, New York 17, N.Y.

FOR GIANT CRANE OR SMALL HOIST

YOU CAN RELY ON "SHAW-BOX" KNOW HOW



"Shaw-Box"
Ladle Crane.
100 to 400 tons.

'Tipit'
A Sling for
Tipping Loads.
1 ton.

'Tugit'
Lever-Operated
Hoists. Portable.
1 and 2 tons.

'Budgit'
Chain Blocks.
¼ to 10 tons.

'Load Lifter'
Traveling
Cranes.
1 to 20 tons.

'Load Lifter'
Jib Cranes.
Full revolving.
¼ ton and up.

'Load Lifter'
Wire Rope
Electric Hoists.
½ to 20 tons.

'Budgit'
Electric Hoists.
⅛ to 2 tons.

Steel production and processing demand overhead load-handling equipment of many types and capacities. Whether it is a crane to handle molten steel or finished products, or a hoist to facilitate shipments or plant maintenance, complete dependability and highest performance are essential.

Mills everywhere have long benefited from "Shaw-Box" research, engineering and production facilities. The same kind of professional know-how that interprets crane requirements to AISE Specifications No. 6 or your own is engineered into all products bearing our brand names. You are assured of precision craftsmanship, top efficiency and economical service from our smallest hoists as well as our huge multi-motored cranes.

If you want to equip your mill with a new soaking pit carriage, a crane of any type and capacity or hoists for any purpose, your inquiry is invited.

"Shaw-Box" CRANES

MAXWELL M&M MANNING & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION, MUSKEGON, MICHIGAN

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Makers of 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

Straightens tubes of standard wall thicknesses, in all grades, from 4½" to 16½"

...40 TIMKEN® bearings carry the load!

WHEN the Sutton Engineering Company built their new No. 5 M KTC tube straightener, they knew it had to give many years of rugged service despite heavy loads and constant use. So they mounted the two driven rolls, five idler rolls, speed reducer and table rolls on Timken® tapered roller bearings.

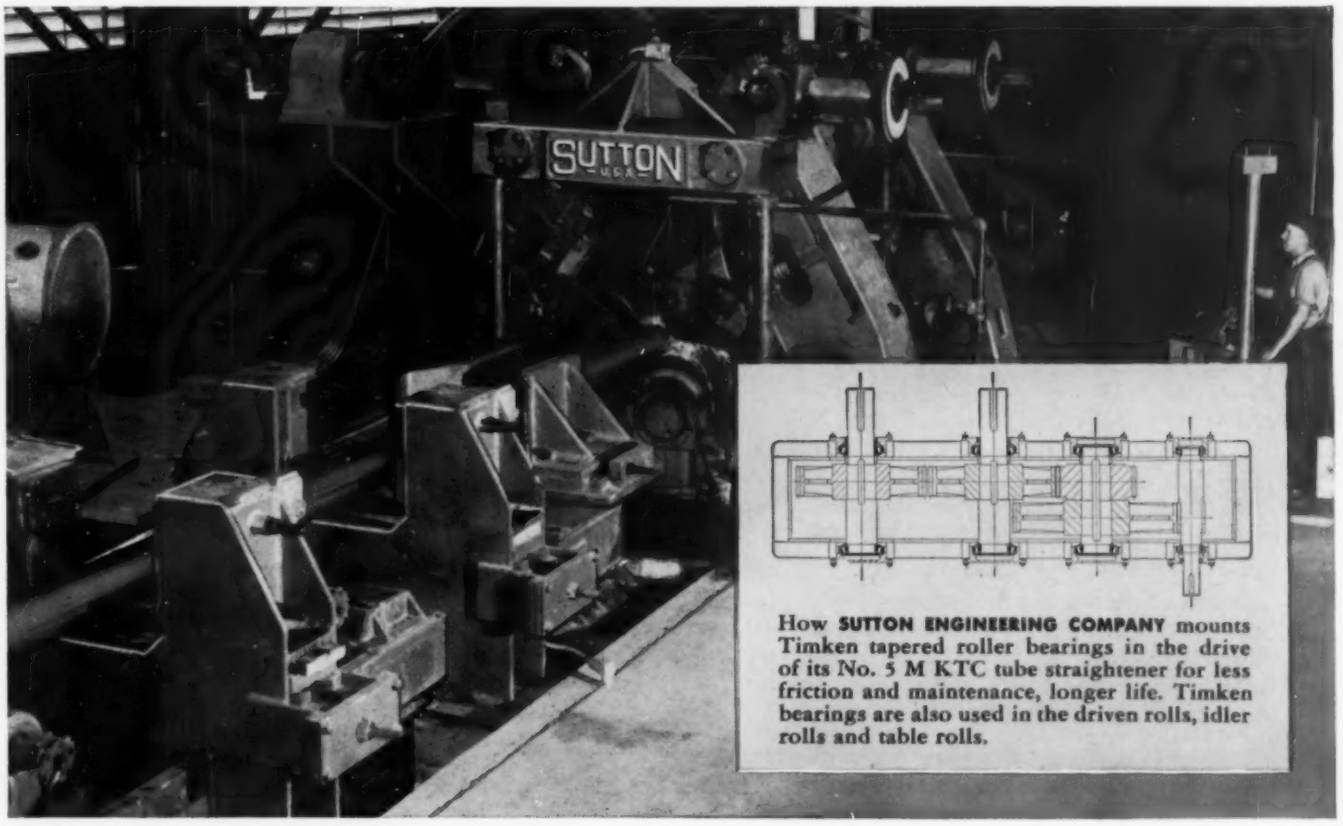
Timken bearings on the rolls easily handle the heavy radial and thrust loads as tubes up to 16½" pass through. That's because Timken bearings are tapered—take radial and thrust loads in any combination. No thrust bearings are required. And full line contact between rollers and races gives them extra load-carrying capacity. Timken bearings keep shafts in accurate alignment, assure smooth operation.

The compactness of Timken bearings permits a high load-carrying capacity in a relatively small-size bearing. Valuable space is saved.

Wear is held to a minimum because Timken bearings practically eliminate friction. They're designed by geometrical law to have true rolling motion. They're made with microscopic accuracy to conform to their design. And they're made of steel we make ourselves. We're the only bearing maker in the country who takes this extra step to insure quality.

To get all these advantages, always specify Timken bearings in the equipment you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **SUTTON ENGINEERING COMPANY** mounts Timken tapered roller bearings in the drive of its No. 5 M KTC tube straightener for less friction and maintenance, longer life. Timken bearings are also used in the driven rolls, idler rolls and table rolls.

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

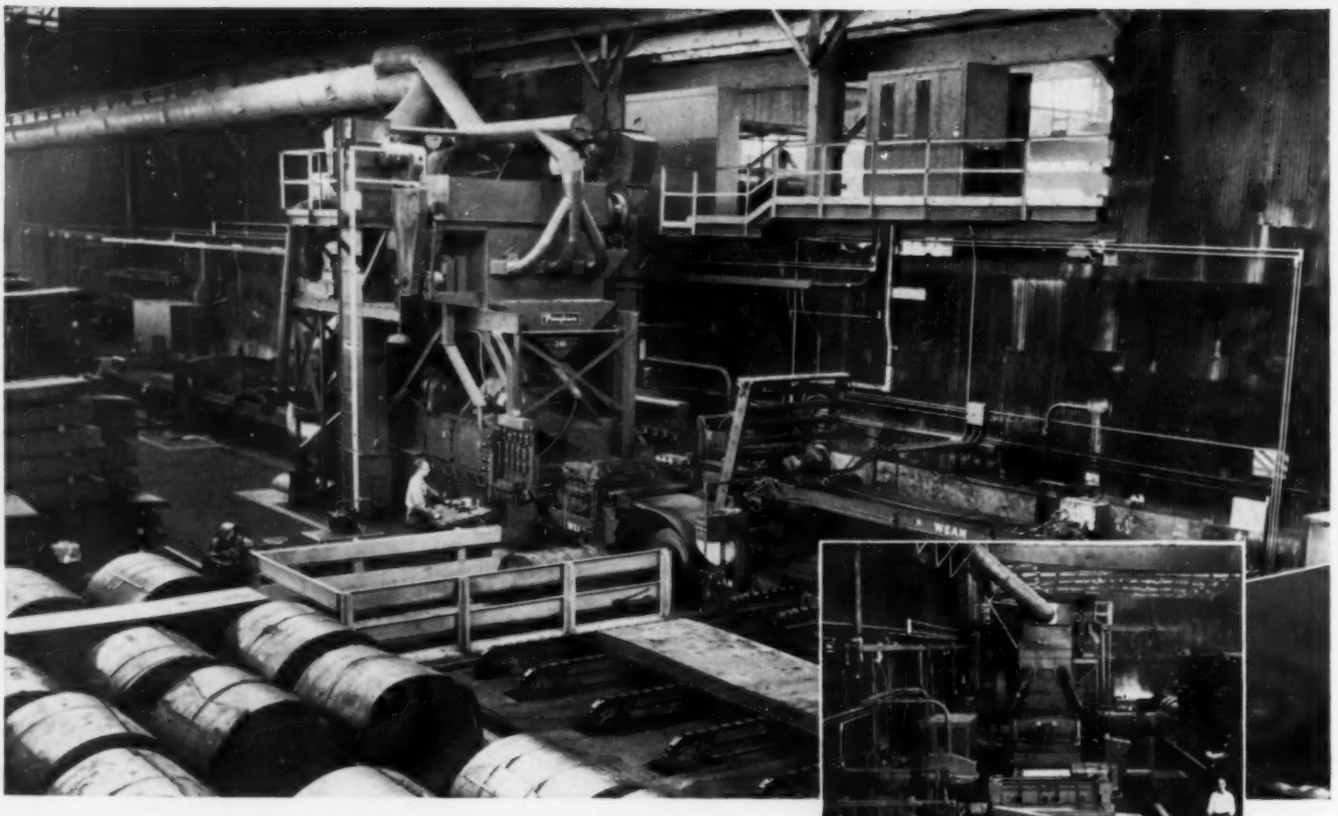
Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

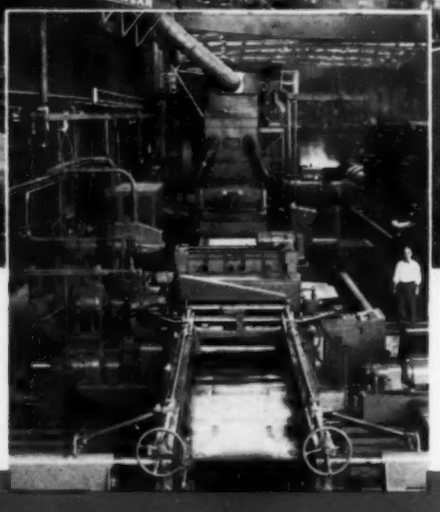
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

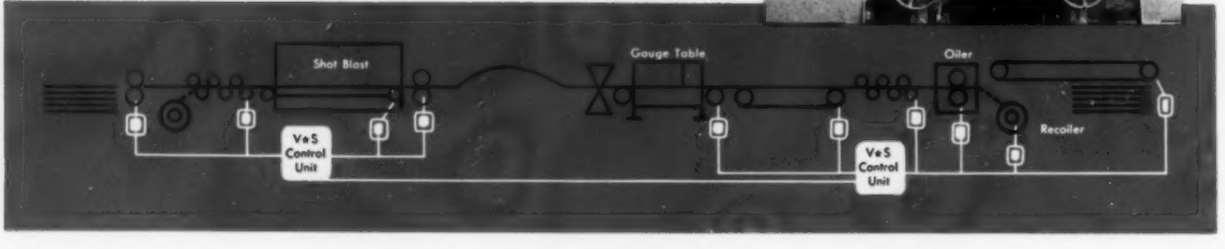
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←





CUTS AND CLEANS UP TO 50 TONS AN HOUR— *Automatically*



It's one of the world's first automotive steel cut-up lines, owned by Parish Pressed Steel Div.—Dana Corp., Reading, Pa. This line cleans, cuts-to-length, lubricates, levels, and coils or stacks up to 50 tons of hot rolled steel an hour.

The line is made up of several separate machines —an uncoiler, a shear, a shot-blast cleaning machine, an unpiler, a lubricator, and a coil winder or stacker —all joined by a conveyor system containing pinch rolls and leveling rolls. Yet the whole line operates as one giant machine, thanks to perfect coordination provided by Reliance V★S Drives.

V★S Drives furnish an unusual flexibility to the Parish line too. Sheet speeds can be varied from 40 feet per minute up to 160 fpm. to accommodate various thicknesses and widths. From the master control, and the three supporting control stations, any one operation or combinations of operations can be eliminated from the line. Thus the line is not limited to just one set series of functions.

This application of Reliance Motors and Drives —to control tension, to synchronize operations, to regulate speed—is typical of the jobs done by the Reliance Applied Engineering Department.

L-1511

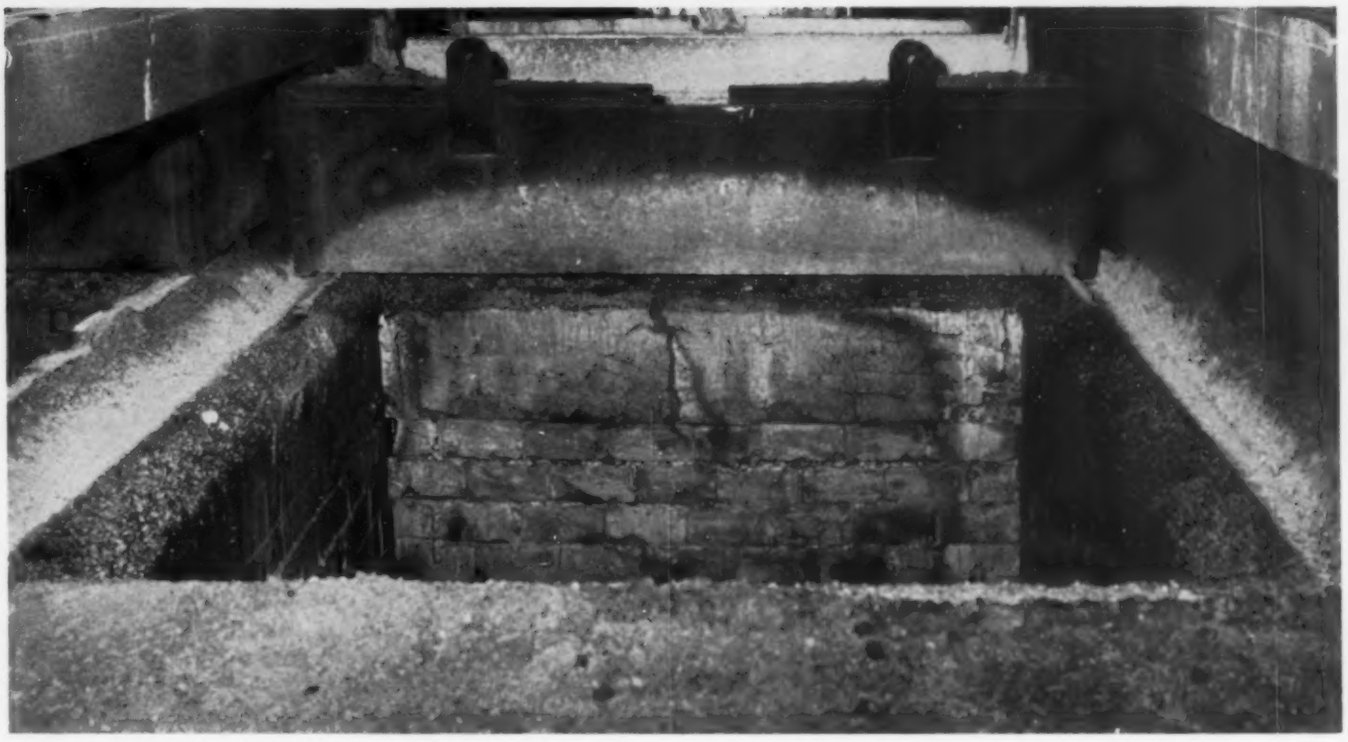
If you would like further information on the application of V★S Drives in your plant write:

RELIANCE V★S DRIVE®

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 116A, CLEVELAND 10, OHIO . CANADIAN DIVISION, WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities



RAMTITE® Soaking Pit Copings Last Longer....

The use of Ramtite in soaking pit copings is one of the many applications of Ramtite Plastic Refractory which has been "on-the-job" tested, again and again, proving to many satisfied customers and to us that Ramtite will often double the life of any other refractory material.

The Ramtite coping pictured above was in service for more than a year before it was photographed. The customer who installed this coping has expressed its satisfaction in the most conclusive way — by installing Ramtite copings in 24 of its pits, and changing over the balance as replacements are needed.

Some of the reasons why Ramtite has proven so successful in soaking pit copings are:

- Ease of Installation
- Inherent Spall-resistance
- Resistance to Physical and Thermal Shock
- Monolithic: No joints for ingot fins to hook into

In addition to copings, Ramtite has proven itself the answer to refractory needs in soaking pit covers and sidewalls and in linings of all heating furnaces. For more information about the uses of Ramtite Plastic Refractory, contact your local representative or mail the coupon below.

RAMTITE IS OUR BUSINESS... NOT A SIDE LINE

The Ramtite Co. offers you a complete sales engineering service — experienced men who are always available to study your refractory problems and consult with your Mason Supt. about your specific needs.

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 South Rockwell St., Chicago 9, Ill.

Please send items checked

☐ Bulletin on Castable and Gunning Refractories
☐ Steel Plant Bulletin

Company Name_____

Attn. Mr._____ Title_____

Address_____

City_____ Zone____ State_____

© 1956

This is another in a series of advertisements depicting ways Ramtite Refractories serve the steel industry

BLAW-KNOX

makes what it takes

to hot roll high-tonnage

top quality sheet

This CONTINENTAL 80-inch, 6-stand continuous hot strip mill in the United States Steel's Gary Sheet and Tin Mill was designed and engineered for heavy duty and high-speed finishing. It is well-known throughout the industry for excellent tonnage performance and quality.

In addition to these large mills, Blaw-Knox builds single-stand reversing hot strip finishing mills, complete with all auxiliaries.

Blaw-Knox designs and builds *complete* rolling mill installations—assumes undivided responsibility from preliminary engineering to satisfactory operation. At any time we'll be glad to discuss your plans with you.

BLAW-KNOX COMPANY
Foundry & Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

Complete rolling mill installations . . . including all auxiliary equipment . . . for ferrous and non-ferrous metals

Hot strip mills • cold strip mills • slabbing mills • temper mills • universal mills • plate mills • blooming mills • structural mills • rail mills • billet mills • rod mills • merchant mills . . . roll lathes • chippers • special machinery • and complete auxiliary equipment

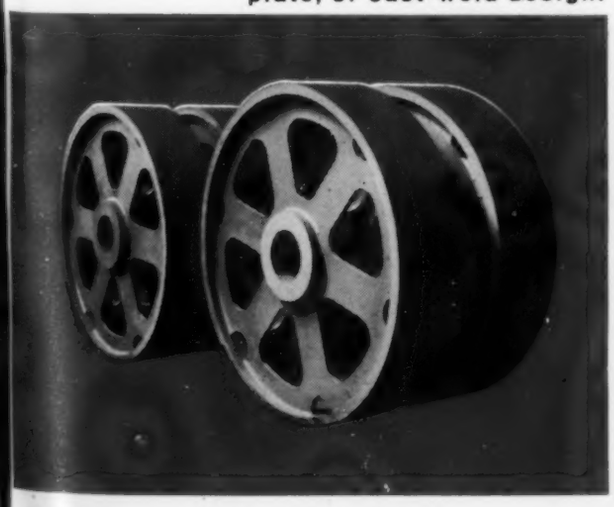
ROLLS—Iron, alloy iron and steel rolls for all types of rolling mills.

50th Anniversary
BLAW-KNOX
1906-1956

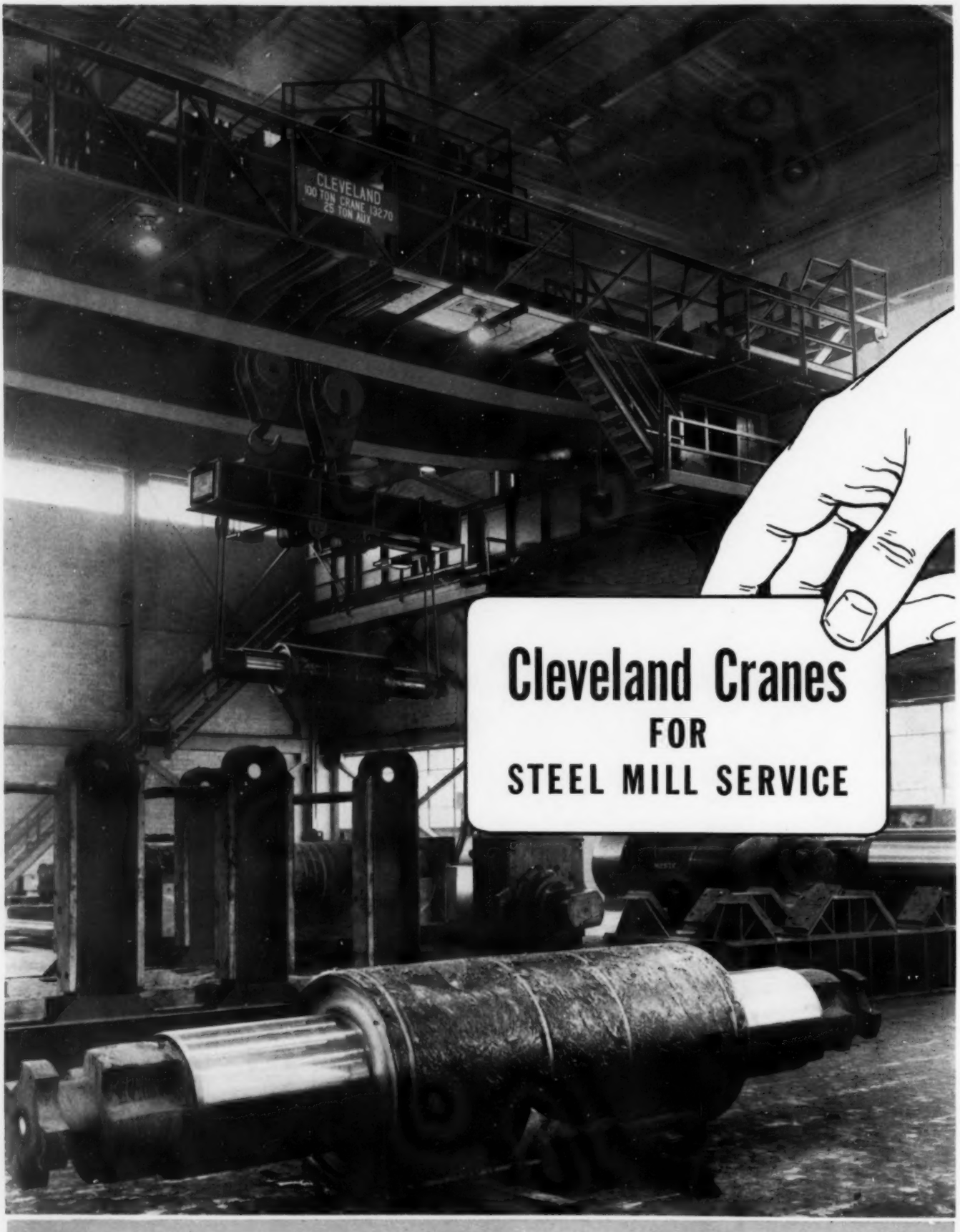
CONTINENTAL
Foundry & Machine

CONTINENTAL 80-inch continuous hot strip mill in the Gary Sheet and Tin Mill of the United States Steel Corporation.

WELDMENTS—fabricated steel plate, or cast-weld design.



CASTINGS—carbon and alloy steel castings from 20 to 250,000 pounds.



Cleveland Cranes
FOR
STEEL MILL SERVICE

CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

ANNUAL negotiations between labor and management in the steel industry have become as much of a mile-stone on our calendar as spring housecleaning, Christmas, etc. And like some of the other mile-stones, each one costs us money.

The United Steel Workers package of 1956 asks for a wage increase, supplemental unemployment protection for 52 weeks, premium pay for Saturday and Sunday work, increased vacation and insurance plans, and the union shop. The cost of this package has been estimated to total as much as 60 cents an hour, which would put the average hourly wage for the industry over $3.00.

Whatever compromise comes out of the current negotiations, it seems certain that the payroll cost will go up perhaps 30 cents per hour and steel prices will advance perhaps $15.00 per ton — and there goes another round (the eleventh) on the inflation spiral.

▲

AN experiment in the negotiations this year is the joint meeting of representatives of United States Steel, Bethlehem and Republic with the union representatives. It is felt that joint conferences will save time. Although each company is on its own to bargain individually, the union has expressed its desire for industry-wide bargaining such as that in the coal industry.

▲

ONE thing that might lead many of us to a false sense of prosperity is the bulge that credit cards make in one's wallet.

▲

INDUSTRY in the United States will spend about $3,000,000,000 on research in 1956.

▲

AT the beginning of this year, stockholders in the iron and steel industry totaled almost 819,000, while employees of the industry numbered about 805,000. That's something for politicians to think about.

▲

STATISTICS from the American Iron and Steel Institute show that the industry, during its record year of 1955, used 138,800,000 net tons of iron ore, nearly 64,000,000 net tons of iron and steel scrap, 70,600,000 tons of coke, 38,300,000 tons of fluxes, 297,000,000,000 cu ft of natural gas, 851,000,000,000 cu ft of coke oven gas, 434,600,000 gal of tar and pitch, and 34,838,000,000 kwhr of electric power. Consumption of coal for all purposes was 100,324,922 net tons.

▲

A contemplative friend observes that there's nothing we can do about birth or death except enjoy the interval between.

▲

POWER brakes are wonderful — they stop a car on a dime. But it costs a lot more to fix up the passengers' broken noses.

▲

OVERALL college enrollment is above the high levels of the G-I bulge of 1947-1950. Engineering enrollment is currently behind the overall growth, but is very close to the highest levels reached in the latter 40's.

Nevertheless, the shortage of engineers persists, and this year's engineering graduates are going into industrial jobs at salaries of about $5000 a year. Doctorate degrees seem to find jobs at $8000. Such pay scales are enticing college teachers into industry, with the result that schools are short of good teachers. Salary raises seem to be due in the colleges.

However, as we have said previously, we feel that engineers are not being used efficiently. Too many are put in jobs that could be satisfied by other training, and some companies are actually hoarding engineers. Also, we have expressed the belief that engineering teachers could carry heavier schedules than now exist.

Thorough consideration of these points might uncover some help in meeting the current situation.

▲

WHENEVER we hear someone grumble about growing old, we wonder how they'd like to be denied the privilege.

▲

LOW water supplies present an increasingly serious problem. Estimates indicate that by 1975, water requirements may total 341,000,000,000 gallons per day. Increased reuse of water by industry will be essential.

▲

MAYBE it's just a sign of the times, but the manufacturer of a mechanical multicolor pencil is bringing out a platinum job to retail for about $500.

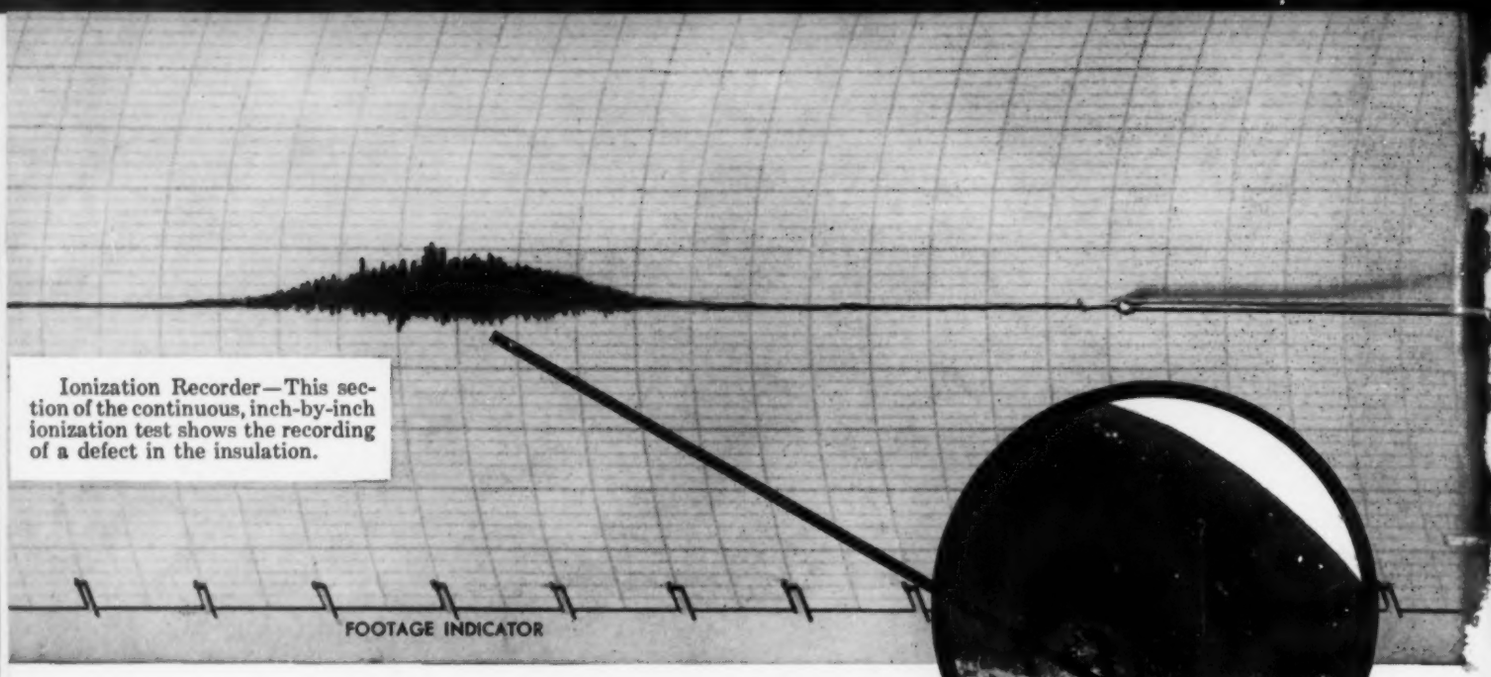
▲

JOHN N. Marshall, president of Granite City Steel Co., believes the "credit union is one of the happiest chapters of labor-management relations."

Employees in the iron and steel industry now operate 250 credit unions in North America.

▲

WITH vacation-time coming up, the Houghton Line suggests: "Drive safely — just like you do when a police car is behind you."



Ionization Recorder—This section of the continuous, inch-by-inch ionization test shows the recording of a defect in the insulation.

This void was detected by the "Gooding Test Train" ionization test. It was *not* detected by any of the industry's standard test procedures.

New Testing Procedure developed by Okonite

"Gooding Test Train" detects flaws in insulated power cable (4kv and over) heretofore unrevealed by standard tests

The "Gooding Test Train" has significant value to cable users. This new system of *non-destructive* testing, developed and used only by Okonite, reveals imperfections which are frequently not detected by ordinary testing procedures. Some of them even slip by Okonite's super-voltage a-c and d-c tests (highest used in the industry) and "full reel" corona tests.

The "Gooding Test Train" consists of a series of three test sets. The entire length of cable passes consecutively through each set as follows:

SCHEMATIC DRAWING OF GOODING TEST TRAIN

1. Uniformity Test—A uniformity gauge continuously checks insulation thickness—locating any thin spots which might cause premature failure.

2. Ionization Test—This is the most important unit of the "Gooding Test Train". It can measure the corona level at any spot along the cable. Procedure is to test the cable *inch-by-inch* at a predetermined voltage which is sufficient to assure the user that the corona level is at least 1½ times the rated voltage. Voids and imperfections as small as a grain of sand have thus been identified and removed.

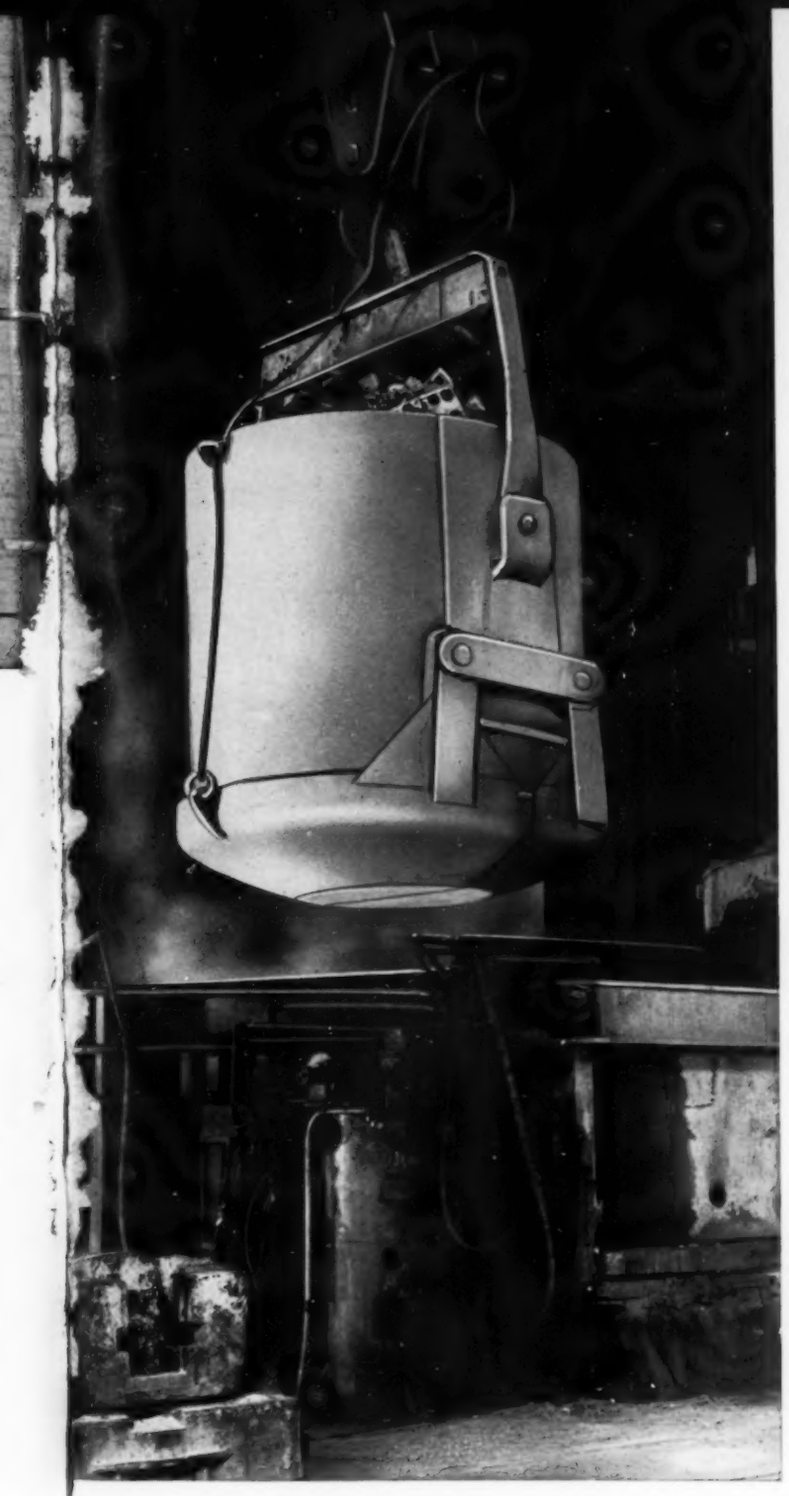
3. X-Ray Test—X-ray inspection of the cable is performed by a 250,000 volt X-ray machine. This determines the nature and extent of any of the flaws indicated above.

By such intensive testing, it is possible to eliminate previously unidentified imperfections that might otherwise lead to premature failure. Studies of such defects also help to identify the cause and permit preventive measures. The "Gooding Test Train" is now being used to test all Okonite's rubber-insulated cables rated at more than 4000 volts. It is a long step towards securing the "perfect cable" and, as such, of tremendous benefit to cable users.

For detailed information about Okonite's G.T.T. write for new Bulletin IS-1100, to The Okonite Company, Passaic, N. J.

3804

OKONITE SINCE 1878 *insulated cables*



STEEL PLANTS

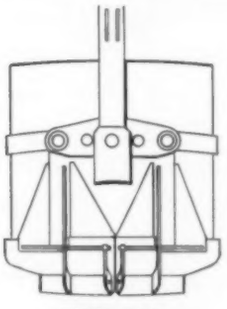
separate men from boys

THAT'S WHY McGREGOR-MICHIGAN FABRICATIONS *EXCEED* SPECIFICATIONS

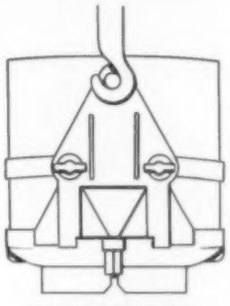
Yes, in many cases where additional weight does no harm, we throw the specs out of the window—and you get a job that gives you a minimum of maintenance headaches for years to come. McGregor-Michigan Fabrications take their place among the "men" in primary metal plant equipment because we know they'll get slammed around and we build them to stand up to rough treatment!

Our clam-bottom scrap buckets, for example, have design and structural features which now set the pace for the industry and our engineering department is continually at work to make all such equipment more rugged, easier to maintain, safer, less costly. Some of the most progressive plants in the world tell us that our modern engineering service, *backed by 115 years of heavy fabrication experience*, has made a valuable contribution to their efficiency.

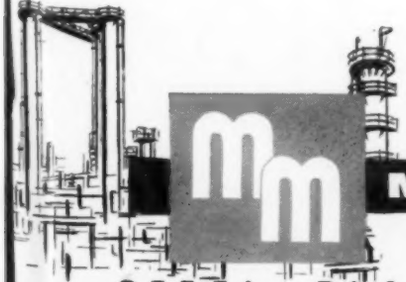
Think of McGregor-Michigan for every type of welded or riveted fabrication. Just send prints for quotation and depend upon our experienced representatives to work closely with your engineering staff to the completion of the job.



FIXED BAIL



REMOVABLE BAIL



TRINITY 2-2400

McGREGOR-MICHIGAN CORPORATION

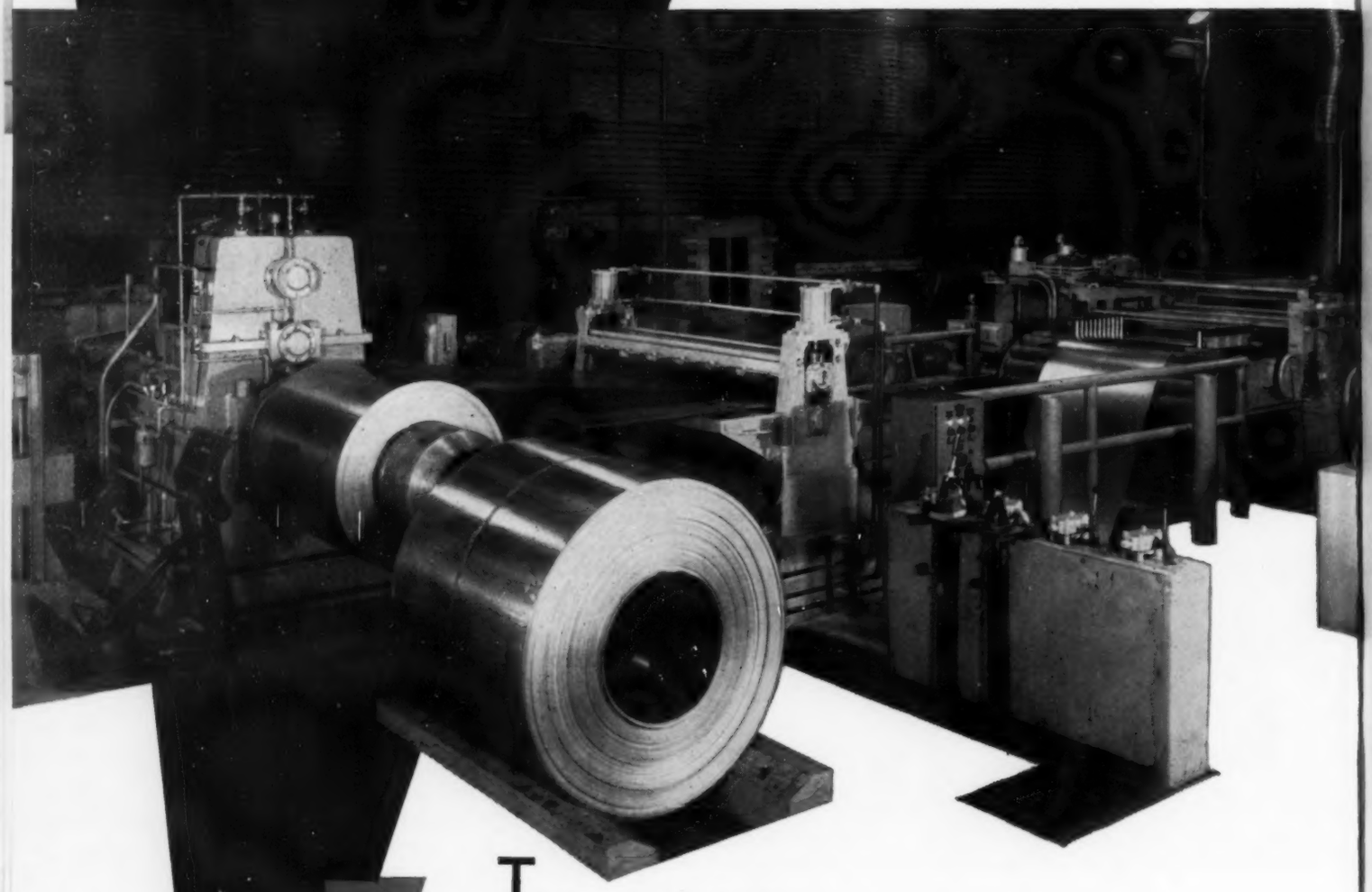
5820 RIVARD ST. . DETROIT 11, MICHIGAN

STEEL PLATE FABRICATING AND WAREHOUSING

The WEAN

Engineering Company Inc.

Warren, Ohio . .



THE Wean Engineering Company, Inc., Warren, Ohio, is a recognized specialist in the design and installation of sheet, tin and strip mill equipment. The expert knowledge and trained imagination of one of the world's most noted steel mill engineering firms is at your service when you specify Wean — whether the job calls for a single piece of equipment or a complete design of an entire line.

SPECIALISTS IN SHEET, TIN & STRIP MILL EQUIPMENT

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T. J. ESS
Empire Building
Pittsburgh, Pa.

Iron and Steel ENGINEER

JUNE, 1956 VOLUME XXXIII NUMBER VI

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Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds)... $ 7.50 per year
Subscription price in foreign countries (U. S. funds) ... $10.00 per year

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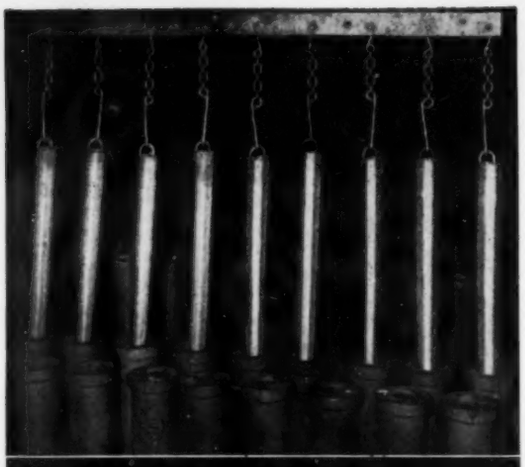
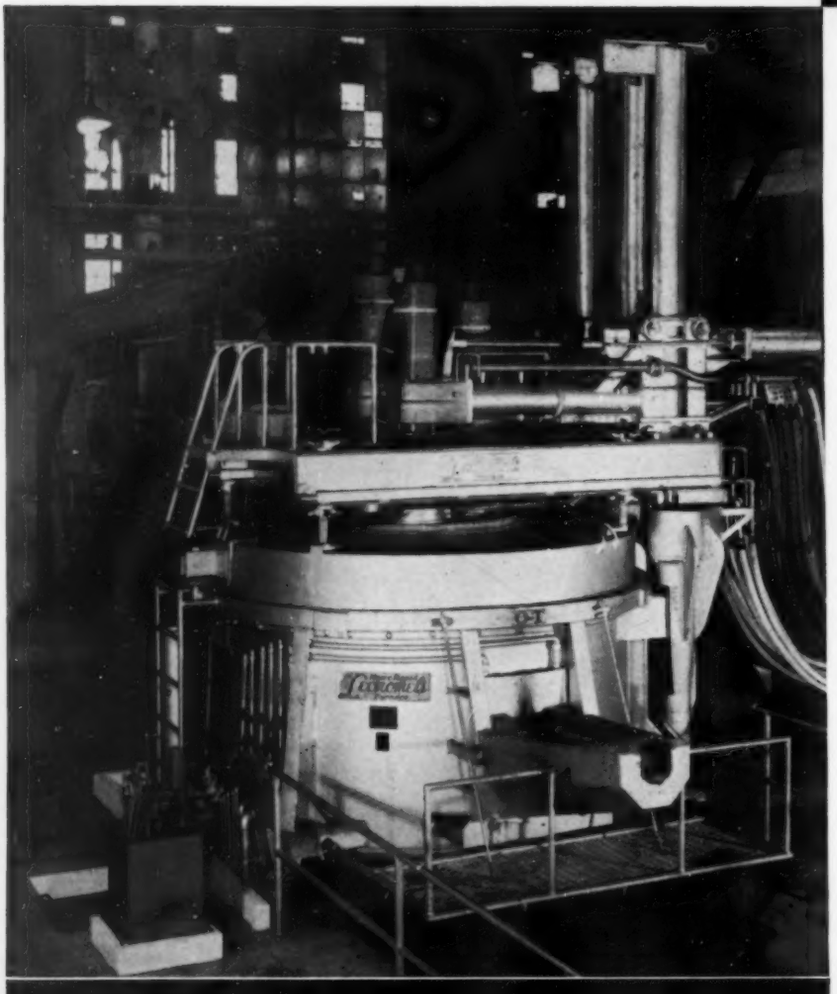
Success in producing billet-size ingots with their Lectromelt* Furnaces causes Connors Steel to add another



Stripping billet-size ingots at Connors Steel, Birmingham, Alabama.



As part of their expansion program, a Size OT 11-foot diameter Lectromelt Furnace like this one has recently been installed at this division of H. K. Porter Company

"We've bought a fourth Lectromelt Furnace because we're 100% satisfied with our three previous Lectromelts", reports Mr. J. B. Reeves, Works Manager for Connors Steel Division, H. K. Porter Co., Inc. of Pittsburgh, Pa. "We cast 4" to 8" billet-size ingots, thereby by-passing any need for soaking pits and a blooming mill."

Billet-size ingots solidify rapidly, resulting in uniformity and fine grain structure. Merchant shapes and reinforcing bars are produced from them now at Connors Steel, with cold finished bars to be added early in 1956.

Lectromelt Furnaces used generally on billet-size ingot work vary widely in capacity, ranging from units making heats of 500 pounds up to 15-ton heats. Of course, other Lectromelt Furnaces in capacities up to 150 tons are regularly used for producing heavy ingots.

Catalog No. 9-B describes Lectromelt Furnaces for all metal melting and refining work. For a free copy, write Lectromelt Furnace Company, 310 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

Manufactured in . . . ENGLAND: Birlec, Ltd., Birmingham . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa . . . JAPAN: Daido Steel Co., Ltd., Nagoya

*REG. T. M. U. S. PAT. OFF

WHEN YOU MELT... MOORE RAPID *Lectromelt*

Basic Formulas for Roll Design and Rolling of Alloy Steels

This article is a basic manual on the rolling of alloy steels which will be of extreme value to rolling mill operators producing alloy products and to the young and new engineers who are getting started in the alloy field.

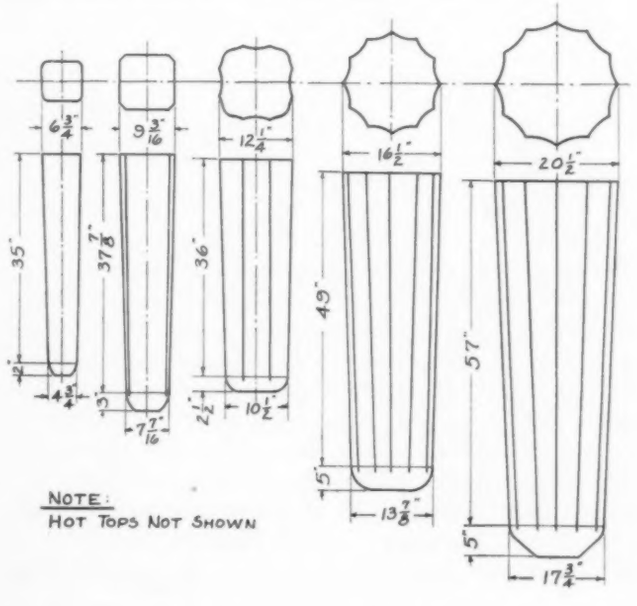
By A. M. CAMERON
Superintendent
Blooming and Bar Mills
Atlas Steels, Ltd.
Welland, Ontario, Canada

▲ PUBLISHED literature on the basic principles of roll design and rolling, have with few exceptions made little reference to rolling of alloy steels. This paper will, however, discuss the basic formulas used in roll design and rolling of alloy steels, with only minor reference to metallurgy, mill layouts, or pass design for complicated shapes.

Although a formal education is most desirable in this work, it is also important that one has the ability to absorb rolling mill information as published, or handed down by those of experience. It is also important to be observant enough to visualize what occurs when a hot piece of steel is passed between two driven rolls, and then be able to construct the basic formulas that can be applied to the various phases of rolling.

Generally speaking, one must be able to solve problems in geometry, trigonometry, algebra, ratios, and also understand the many standard formulas already in use.

Figure 1 — Sketch gives typical range of ingot sizes and shapes which are used for alloy steels.



INGOTS

It is important that the roll designer and rolling mill personnel have some knowledge of mold design and the characteristics of a cast ingot, not only regarding size and shape, but also internal structure, most of this information can be obtained from the metallurgist and mold manufacturer.

Since there are well over 300 different grades of alloy steels being rolled, a very wide range of ingot molds are necessary to produce a sound ingot. When selecting an ingot mold, first consideration is usually given to the various cross sections and weights required to enable proper reduction to final size, and at the same time meet metallurgical specifications.

After the cross sections have been determined, then the volume or weight has to be calculated. Practically all alloy steel ingots are cast in tapered molds with the big end up and hot topped. There are definite ratios between diameter, length, taper, and thickness of the mold walls which must be adhered to within fairly close limits.

When figuring ingot weights from mold volume, the figure of 0.260 lb per cu in. is generally used. This takes into account shrinkage and a loss of about 4 per cent below the hot top.

Figure 1 shows a typical range of ingot sizes and shapes commonly used. Note that the smallest ingot

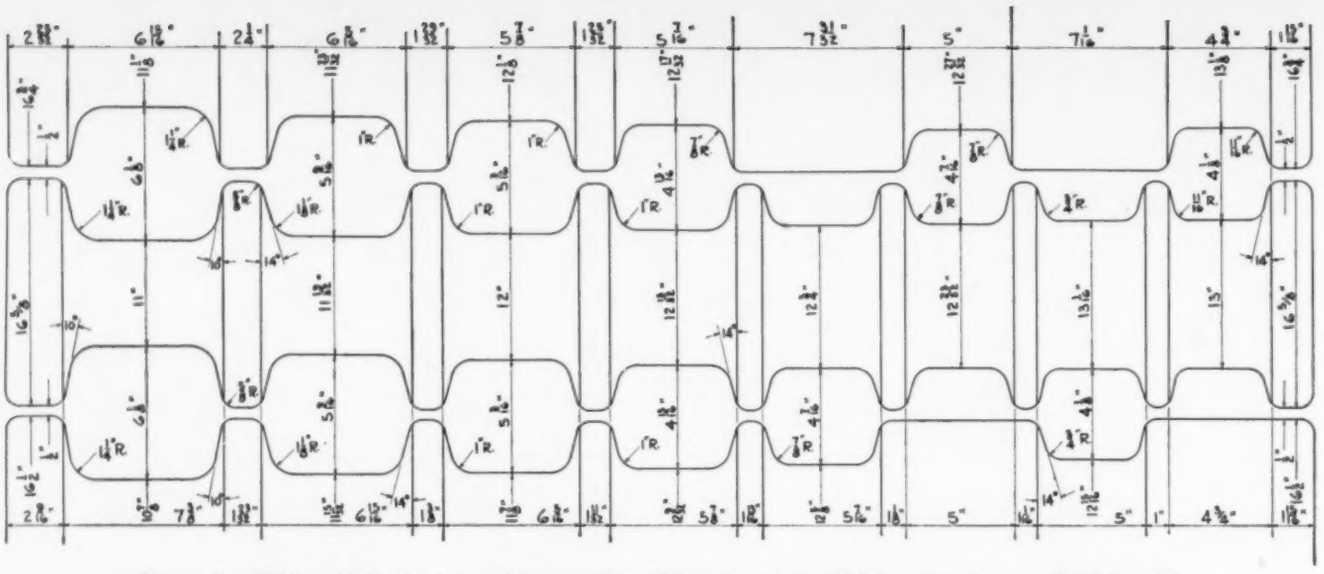


Figure 2 — This roll design is used for cogging 6¾-in. ingots to 4¼-in. squares on a 3-high mill.

has a taper of about ⅝ in. per ft of length, and the length about five times the top cross section. Note also that as the cross section increases, the taper and ratio of length decreases to where the taper on a 20½-in. ingot is about ½ in. per ft and the length about 2½ times the top diameter. Ingots 16½ in. diam and over are generally cast with adjustable hot tops for different weights.

It must be pointed out that the range of finished product, grades of steel, melting and rolling capacity, will have a distinct bearing on the size of ingots required and also rolling technique. Any drastic changes in mold design should not be made without a full investigation of the particular problem. Changes may mean an entirely new blooming mill roll design.

HEATING AND BLOOMING

Heating of alloy steels is a subject in itself, however, when one has an operation which requires 24 hours of melting and only 8 or 16 hours of blooming, complications are certain to occur.

It is most desirable that all ingots of alloy steel be transferred hot to the soaking pits or heating furnaces prior to rolling with the possible exception of a few grades that may require annealing prior to rolling. In order to schedule the blooming operation successfully, one of four alternatives has to be decided upon:

1. A fast heating cycle to take care of immediate heats.
2. A prolonged heating cycle.
3. Banking and heating from cold ingots.
4. Finally, where it is absolutely necessary to charge ingots hot, and minimize the heating cycles, the melting department must schedule accordingly.

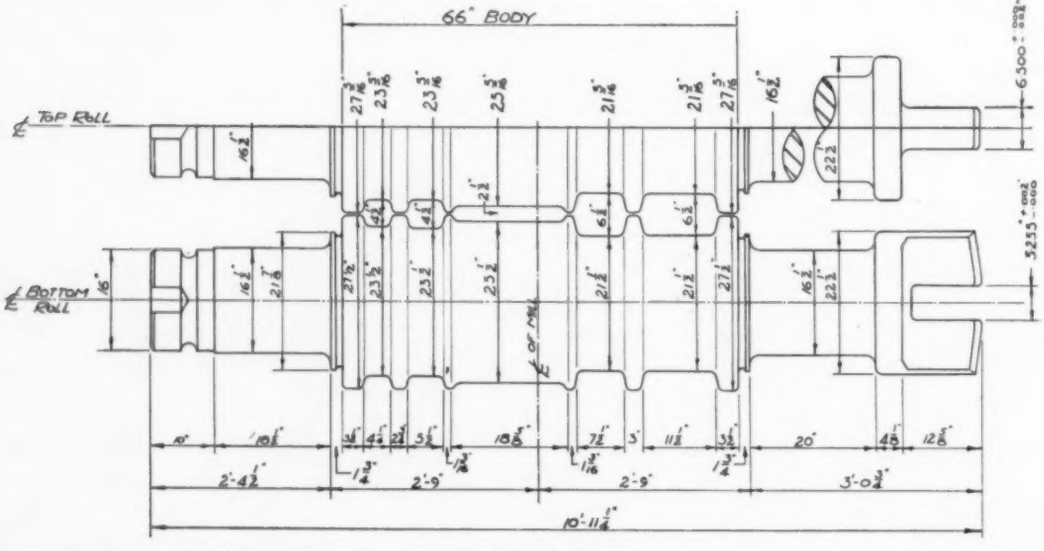


Figure 3 — This roll design is used on a regular 2-high, 26-in. blooming mill.

BLOOMING MILLS

During the early development of alloy steels, it was considered necessary to cast small ingots and to forge or press cog into blooms or billets before final rolling. As production increased and reduction in cost became mandatory, rolling had to be used. Since very few alloy plants were equipped with 2-high reversing mills that could handle small ingots, the 3-high mill had to be used. It was quite obvious that adjustable drafts, although most desirable, could not be accomplished on a fixed mill. Reduction would have to be made to suit the higher alloyed grades and all ingots rolled

through the same sequence of passes. Some mills went so far as to motorize the top and bottom screws in order to have some flexibility. Figure 2 shows a set of 3-high cogging rolls for rolling 6¾-in. ingots to 4¼-in. square.

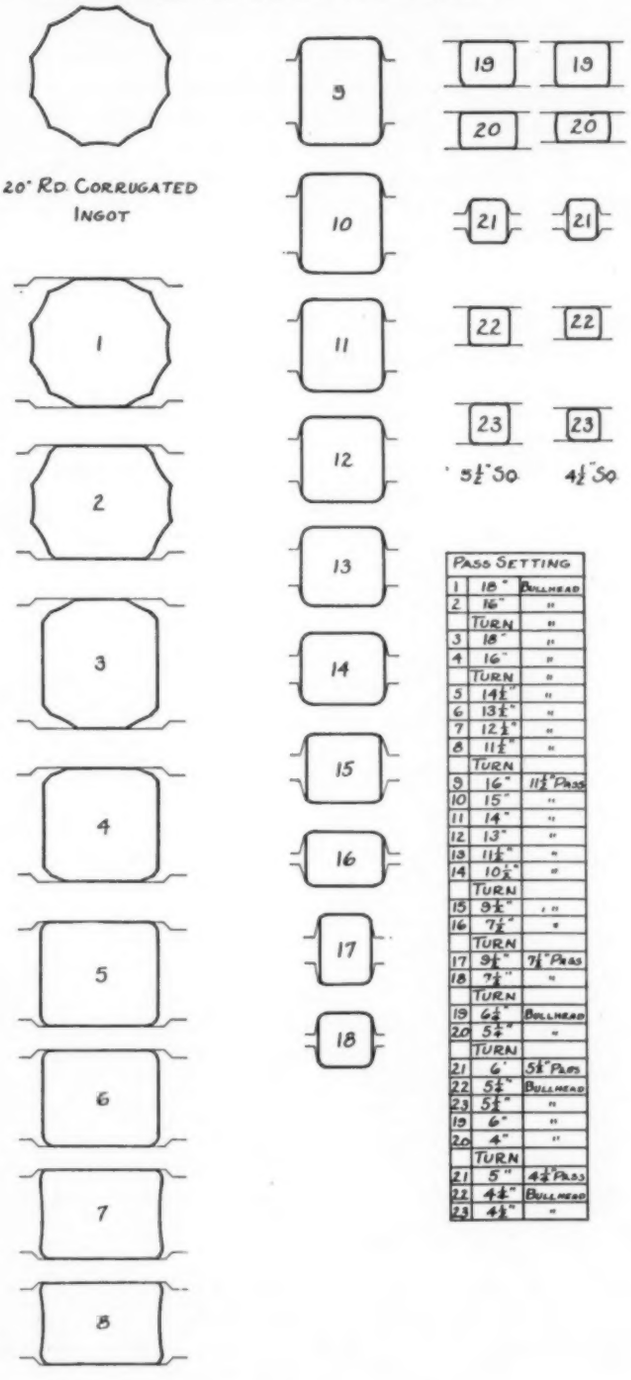
In arriving at a basic roll design for a 2-high blooming mill for cogging highly alloyed steels, first remember, it is not necessary to reduce an alloy steel ingot all the way down in box passes. The 2-high blooming mill of today with proper roll design, Figure 3, speed control and fast manipulation can roll alloy steels, meet all the metallurgical requirements, and can also be used as a high production unit. Working in conjunction with one or more additional stands, the 2-high reversing mill can be used as a roughing stand for rounds, squares, hexagons, octagons and a wide range of flats and shapes.

Time is one of the most important factors in reducing an alloy steel ingot to billet or bloom, and those in the alloy steel business have found that on the basis of time alone, straight flat reduction can be made before closed or box passes are necessary.

The amount of reduction that can be made on each pass on the bullhead of a blooming mill either by straight reduction in one plane or by turning 90 degrees after one or two passes, will depend on the grade of steel and also on the workability of any given heat.

Not more than 45 per cent total draft should be taken before entering the first box pass. The speed of rolling should be kept under 200 fpm until the ingot is reduced to about 25 per cent of the original area. After entering the first pass, all further reduction should be made in box passes until the ingot is reduced to about 15 per cent of its original area, during which time the speed of rolling is gradually increased. From here on down, drafts and speeds can be varied to suit final size. Figure 4 shows a typical sequence of drafts, reducing a 20-in. round corrugated ingot to 5½-in. square.

Figure 4 — Draft sequence for rolling a 20-in. round corrugated ingot to a 5½ and 4½-in. square.



Pass Setting		
1	18"	Bullhead
2	16"	"
	Turn	"
3	18"	"
4	16"	"
	Turn	"
5	14½"	"
6	13½"	"
7	12½"	"
8	11½"	"
	Turn	
9	16"	11½" Pass
10	15"	"
11	14"	"
12	13"	"
13	11½"	"
14	10½"	"
	Turn	
15	9½"	"
16	7½"	"
	Turn	
17	9½"	7½" Pass
18	7½"	"
	Turn	
19	6½"	Bullhead
20	5½"	"
	Turn	
21	6"	5½" Pass
22	5½"	Bullhead
23	5½"	"
19	6"	"
20	4"	"
	Turn	
21	5"	4½" Pass
22	4½"	Bullhead
23	4½"	"

BILLETS AND BLOOMS

Setting up workable billet and bloom standards for all sizes and grades required for the finishing mills, is very important in the rolling of alloy steels.

Consideration has to be given to the ratio of total reduction, and finishing mill requirements. It is good practice to have a standard specifying the minimum size billet or bloom required, rather than the maximum that can be used. The billet sizes should correspond with the roll design of the blooming and billet mills, so that all billets can be made with minimum roll changing or resetting. Figure 5 shows a design used in conjunction with a 2-high blooming mill which will deliver 4, 3½, 3, 2½, 2⅛-in. square billets. To avoid improper reapplication for final rolling, blooms or billets should have an area no larger than one-third of the original ingot top cross section, or 3 to 1 reduction; and for tool steels not larger than 4 to 1 reduction.

With a finishing mill layout designed to flat and edge on the first and second pass, it is quite safe to have a standard to allow a minimum of 5 to 1 reduction in area from billet to finished bar and produce a good clean surface product, even on heavy scaling grades.

If flat and edge passes are not used to remove furnace scale, it may be necessary to have billet standards with as high as 10 to 1 reduction in area to produce a finished surface of equal quality.

It can be readily seen that 10 to 1 reductions would be impossible for rolling large sizes, yet are practical on small sizes. The logical conclusion should be to flat and edge the maximum billet that the mill will take and at the same time, keep in mind that the oval and square design generally used on sizes under 1 in. cross section, will act as cleaning passes for small sizes.

In addition to billet sizes, weights will have to be decided. This will largely depend on the multiple cuts from a given ingot weight, rolling conditions as they exist, such as hot bed length, anneal and heat-treating

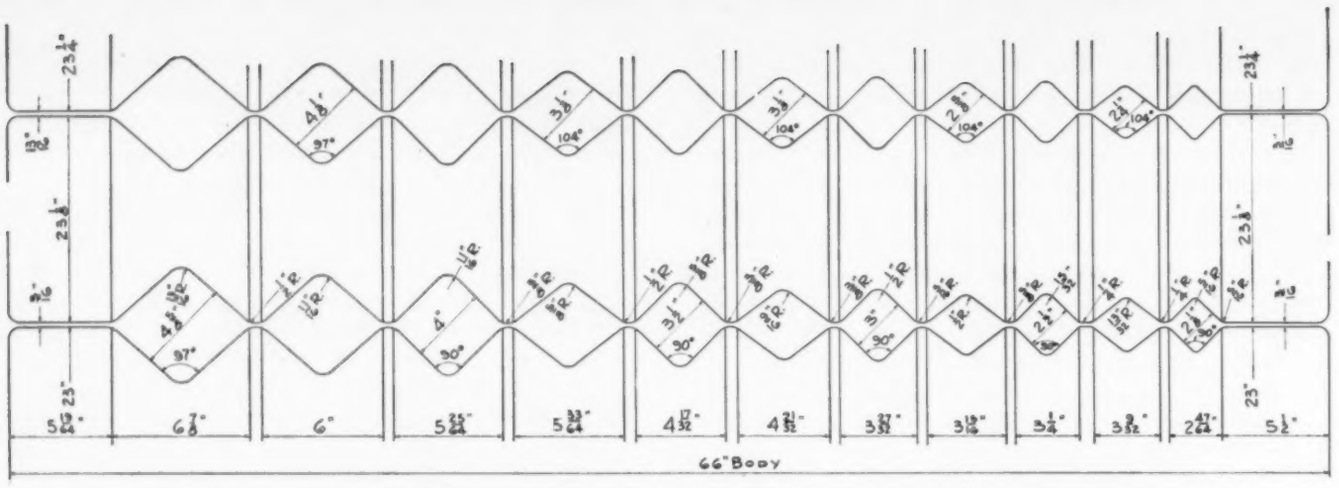


Figure 5 — This 2-high blooming mill roll design will deliver square billets down to 2⅛ in.

capacities, and standard stock lengths. Table I shows a list of multiple cuts from various ingots which also include varied weights from large ingots by means of adjusting the hot tops. Unless exact weights are called for, these weights should show on the mill cog order.

ROLL DESIGN

Roll designs for standard sections such as rounds, squares, flats, hexagons and octagons, are many and varied, and to the uninitiated certainly become confusing to say the least. It is difficult to establish a true basic design for any one of the above sections because of varying elements that go to make up a rolling mill. The data to follow is empirical, rather than based on any particular theory of rolling.

ROUGHING ROLLS

The roughing and intermediate passes for rolling alloy steels is probably the most critical part of the whole rolling mill layout.

Before any definite pass layout can be decided upon, there has to be a complete study made of the sequence of pass design required for each and every size and shape of the product to be rolled, and the billet or bloom size to be used. Following this, the distribution of passes throughout the mill must be decided upon, and finally, design and distribution of passes in each stand or set of rolls.

There are many types of roughing designs used for rolling alloy steels, each designed to roll a particular range of sizes and grades at various rates of production. This article will confine itself to a few of the designs used for roughing and intermediate rolling of various grades of alloy steels.

For simple reduction and as a basic roughing design, Figure 6 shows a first roughing design for reducing a 4½-in. billet to $1\frac{9}{32}$ in. square on a 16-in. mill. A flat and edge pass is used for removing furnace scale and 97 degree open squares are used with 18 per cent reduction in area for the balance of the passes.

Figure 7 shows an intermediate roughing design that will work in conjunction with the first roughing

TABLE I

Ingot size, in. and weight, lb	Conditioned billet weight, lb	Number of cuts								
		2	3	4	5	6	7	8	9	10
9 x 845	610	305	203	152	122	102	87	75	.....	.....
12¼ x 1195	885	442	295	221	177	147	126	110	97	88
14½ x 1970	1420	710	472	355	284	237	203	177	158	142
16½ x 2330	1770	885	590	443	354	295	253	221	197	177
16½ x 2430	1846	923	615	461	369	308	264	231	205	185
16½ x 2530	1923	961	641	481	385	321	275	241	215	192
20½ x 4300	3270	1635	1090	817	654	545	467	409	363	327
20½ x 4490	3410	1705	1137	852	682	568	487	426	379	341
20½ x 4630	3520	1760	1173	880	704	586	503	440	391	352
22½ x 4720	3585	1792	1195	896	717	597	512	448	398	358
22½ x 4950	3760	1880	1253	940	752	626	537	470	418	376
22½ x 5180	3936	1968	1312	984	787	656	562	492	437	393

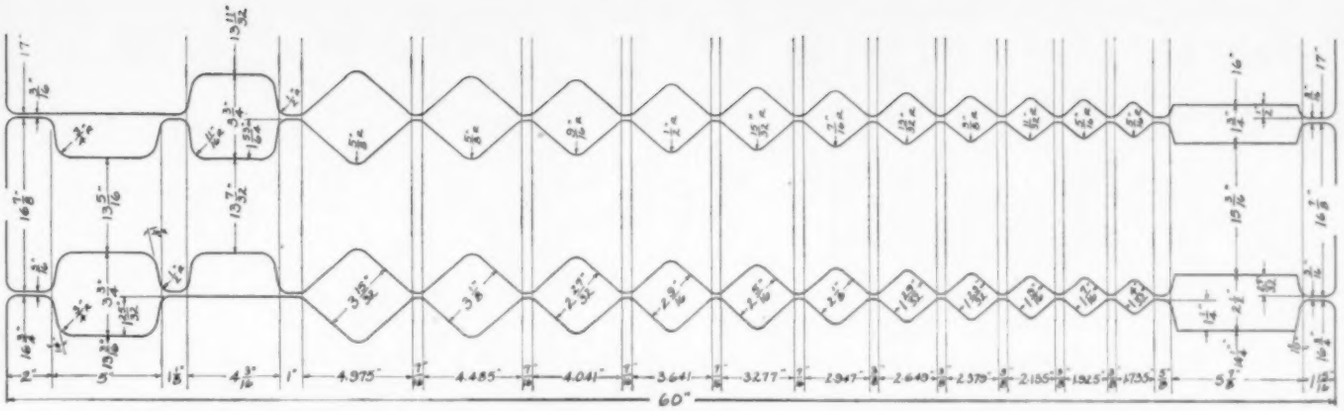


Figure 6 — First roughing design for reducing from 4½ in. to 1⁹⁄₃₂-in. square billet on a 16-in. mill.

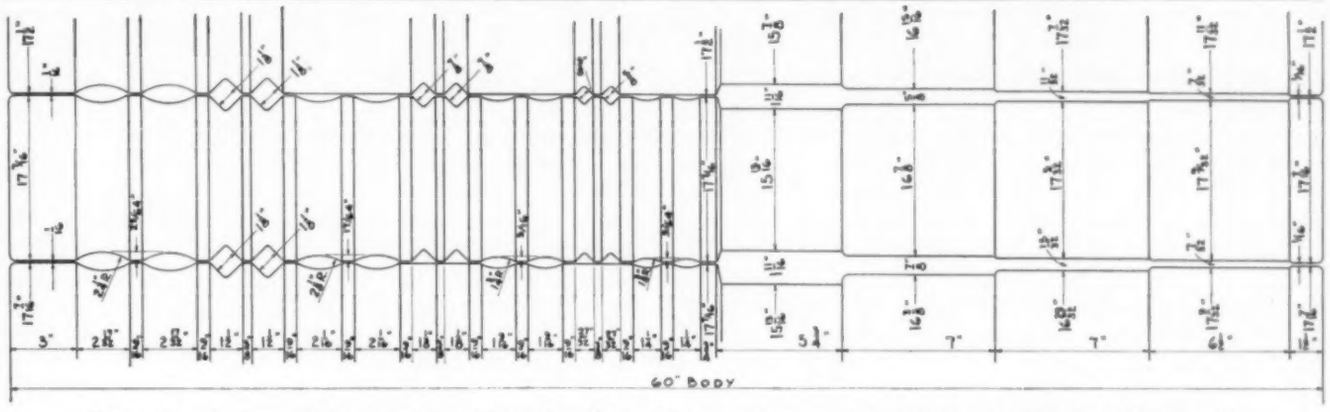


Figure 7 — Intermediate roughing design for 1⅛ to ½-in. ovals as well as full breakdown on a 16-in. mill.

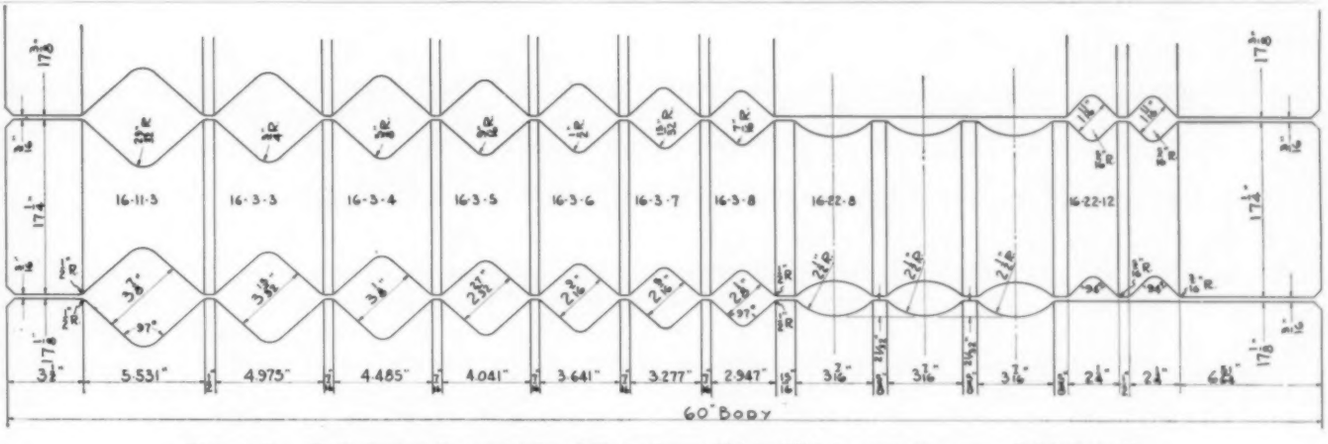


Figure 8 — Roll design for reducing billets from 4½ to 1¹¹⁄₁₆-in. squares on a 3-high mill.

shown in Figure 6, and deliver 1⅛, ⅞, ⅝, and ½-in. ovals as well as flat breakdowns of various thicknesses.

Figure 8 shows a combination of 97 degree open squares, oval, square reduction used in conjunction with two continuous 18-in. stands for reducing 5, 4½, 3½ and 3-in. billets to 1¹¹⁄₁₆-in. square.

Figure 9 shows a combination of open squares, diamond, squares, oval and square passes used for reducing round and square billets up to 3-in. maximum.

Figure 10 shows roughing and intermediate designs applied to rolling some of the standard sections to follow.

It should be noted that the fillet or bottom radius of all square and open square passes are quite large, the purpose of which is to get the maximum roll strength, minimize overfills in succeeding passes, and avoid roll firecracking.

HAND ROUNDS

Hand round rolling is done primarily to produce a wide range of small orders with a minimum number of roll changes, and for rolling some of the highly alloyed steels that cannot be rolled by guides without a special roll design.

Hand rounds constitute a range of finishing passes of standard size increments in a 2-high set of rolls. The finished bar is made by rolling a proper size round cornered or gothic square through a predetermined number of finishing passes down to the size required, turn-

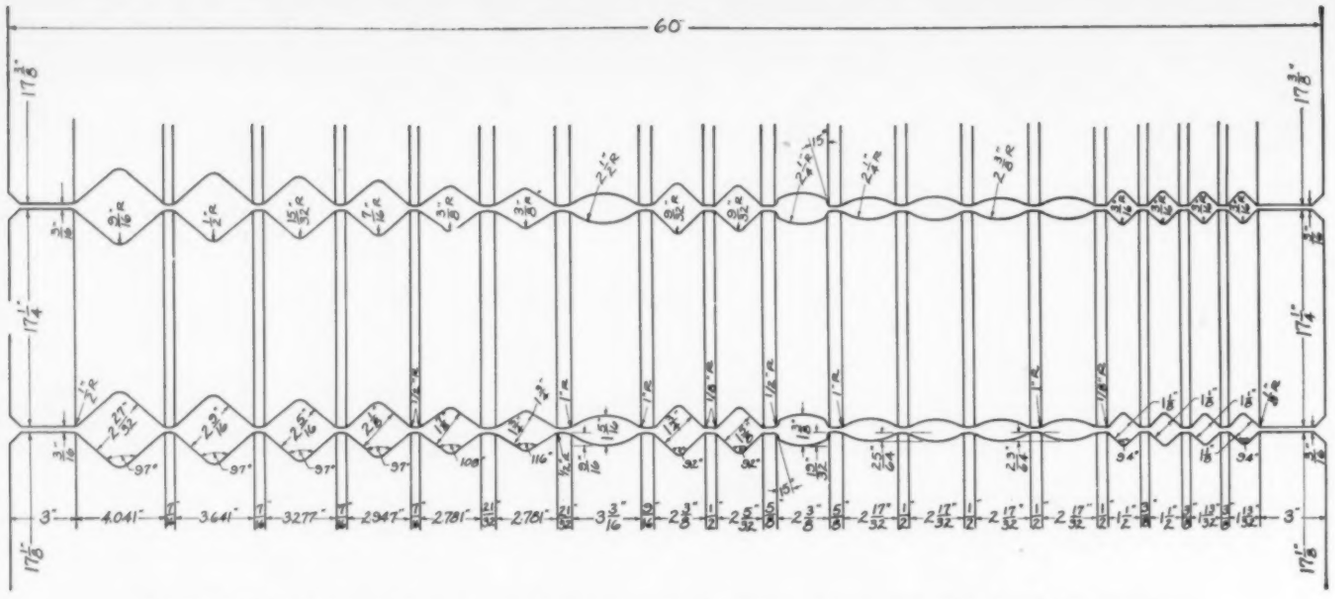


Figure 9 — Roll design shows passes for reducing 3-in. round or square billets to 1⅛-in. squares.

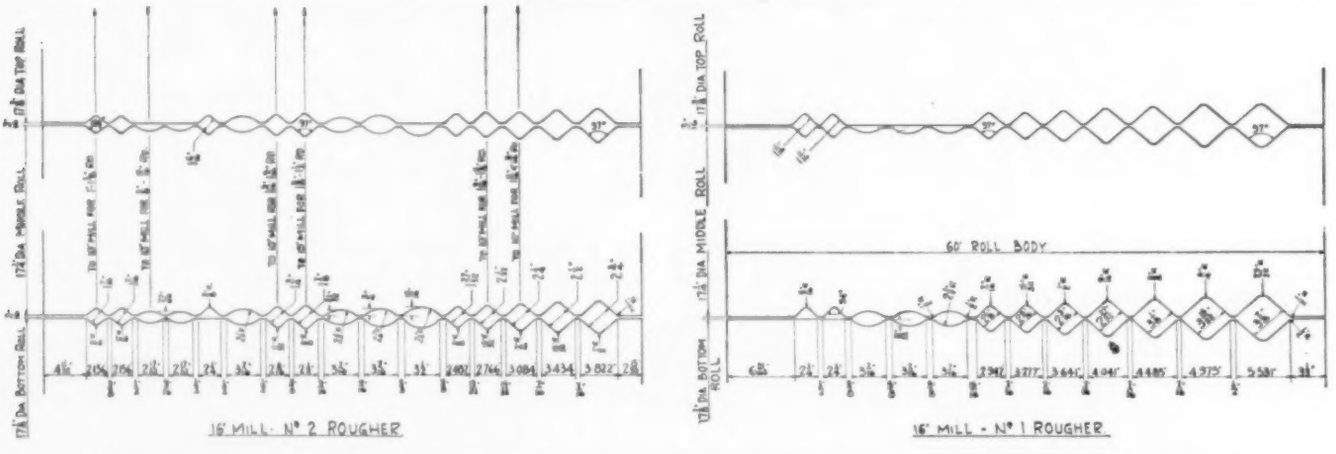


Figure 10 — Roughing intermediate roll designs shown are used for rolling a number of standard sections.

ing the bar 90 degrees after each pass, and finally passing through the last pass four or five times for rounding up.

Guiding the bar through each pass is done by means of hand side tongs and hence the name, hand rounds.

In order to cover standard sizes called for, the rolls are usually designed with the following increments: 1½ up to 3-in. by sixteenths, over 3 to 4¼ in. by eighths and over 4¼ by fourths.

Figure 11 shows a set of hand round rolls for rolling 2⅝ in. up to 3 in. diam.

In order to roll a bar through a series of round passes, opening is required on each pass and apart from perfect alinement of each and every pass, the amount of opening is of importance.

By laying out a series of rolls with increments as noted above, it can be readily seen that the percentage of reduction in area between 2⅛ and 2 in. will be considerably more than between 4⅛ and 4 in., therefore, different degrees of opening should be used.

The degree of opening should not be any more than is required to let the preceding pass roll without overfill; and of course, will depend on the amount of draft from one pass to another.

Radius openings as shown in Figure 12 are widely used, and will vary according to the formula used. However, they all require expensive templates and tools.

A simple opening, Figure 13, is a straight one and can be satisfactorily applied as follows:

Up to 2-in. rounds, 30 degrees.
Over 2 to 3-in., 29 degrees.
Over 3 to 4-in., 28 degrees.
Over 4 to 5-in., 27 degrees.
Over 5 to 6-in., 26 degrees.

GUIDE ROUNDS

There is nothing complicated about the finishing pass for a guide round, however, formulas are being used and are worthy of mention. Since AISI tolerances call for plus and minus on all sizes up to 2-in. diam and an all plus tolerance for sizes over 2 in., when calculating shrinkage allowance and running room or spring, the tolerance has to be taken into account. The standard of 0.012 in. per in., shrinkage allowance works out quite well on sizes up to 2 in., but will likely cause trouble on sizes over 2 in. For sizes

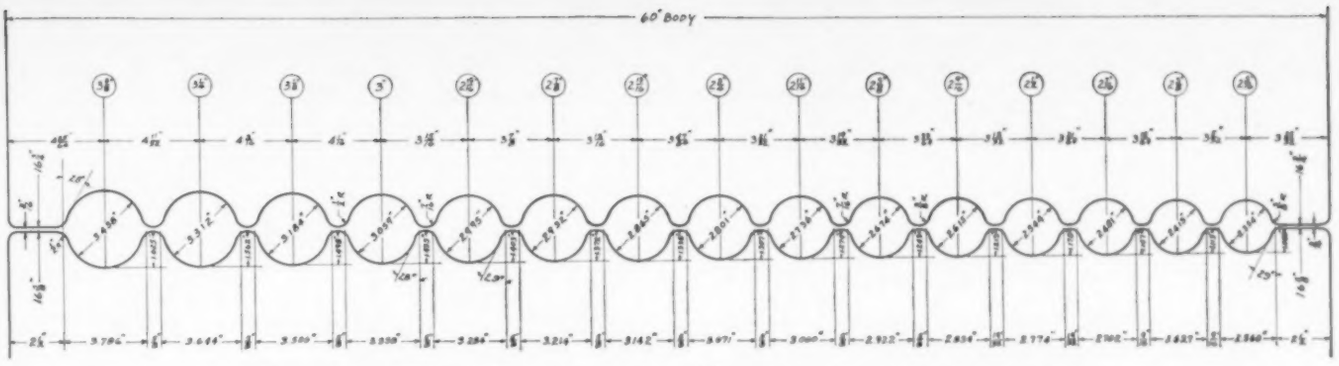


Figure 11 — This roll design is used for 2 5/16 to 2-in. diameter hand rounds.

over 2 in., add one-half of tolerance and then allow 0.012 in. per in. of diam.

A formula for figuring finishing pass depth can be used as follows:

$$\frac{(\text{Cold size}) - (\text{Shrinkage} + 0.014)}{2}$$

Using such a formula will mean a different running room allowance for each size and resetting when rolls are turned with more than one size in a set. For the benefit of the roller, all sizes in a single set should have the same running room. For rolling alloy steels, all rolls should be run as far apart as possible, simply to allow space for bad ends to get through without damage to the collars and also to avoid thin overfills.

GUIDE ROUND LEADERS

Leader pass designs for guide rounds seem to have a wider range of formulas than any other pass in rolling. This is because there is a wider range of sizes rolled than any other section, and are rolled on nearly all sizes and types of mills.

Any leader pass must have a definite relationship to the finishing pass and can be classed as blunt ovals, flat ovals, and double radius ovals.

When establishing a leader pass formula, consideration must be given not only to the size of round but also to the size of mill.

Before laying out any oval leaders for alloy steels, keep in mind that a width of 1.185 times the finished size is about the minimum that can be held up in the finishing pass and an oval with a width of 1.5 to one will be the maximum that will enter the finishing pass freely, therefore, use wide ovals for small sizes and blunt ovals for large sizes.

Maximum sizes that can be rolled on any particular size of mill are somewhat debatable, however, there can be little or no difficulty in rolling guide rounds up to 2-in. on a 10-in. mill (1 5/8 in. for high speed hot work steels and heat resisting stainless), up to 3-in. on a 16-in. mill and up to 8-in. on a 22-in. mill, and this includes all alloy steels normally rolled.

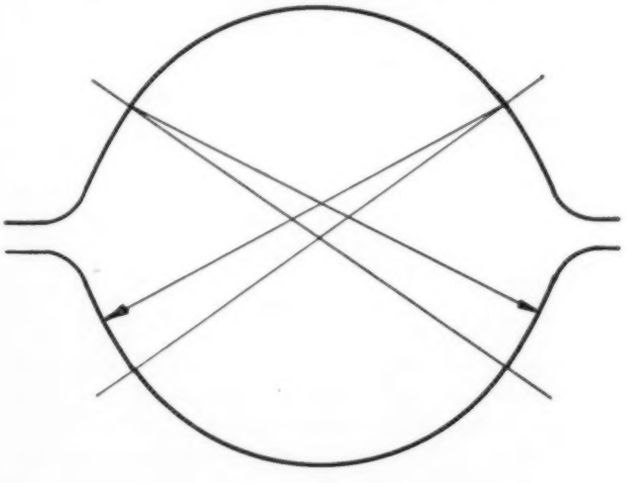
A basic formula and one which is simple and quite accurate is shown in Figure 14.

This particular formula for a 10-in. mill shows a width of 1.5 to 1 and a thickness of 0.9 to 1 for 9/32 in. and a width of 1.4 to 1 and a thickness of 0.93 to 1 for 13/16 in. A single arc is used for all above sizes on a 10-in. mill. For sizes 7/8 to 2 in., double radius oval is used.

Figure 15 shows a formula used for a 16-in. mill on sizes from 1 3/4 to 3 1/8 in. Care should be taken to confine the range of this type of formula to one size of mill. You can have a flat oval for the smallest size and gradually convert to a blunt oval for the largest size on any mill.

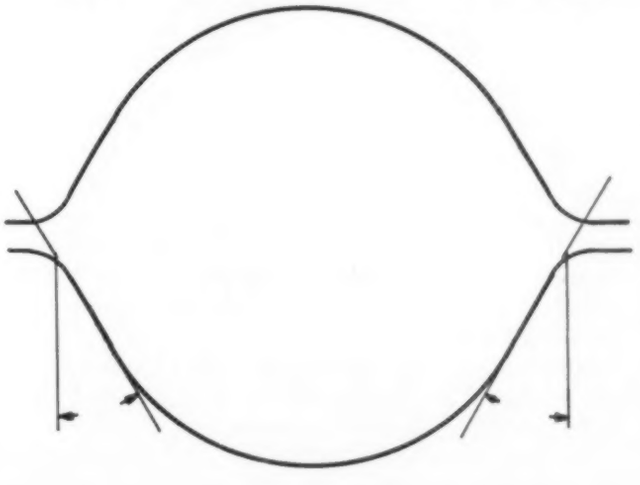
Next to be considered is the range of sizes to be

Figure 12 — Radius openings are widely used.



RADIUS OPENING

Figure 13 — The straight opening is simple in design.



STRAIGHT OPENING

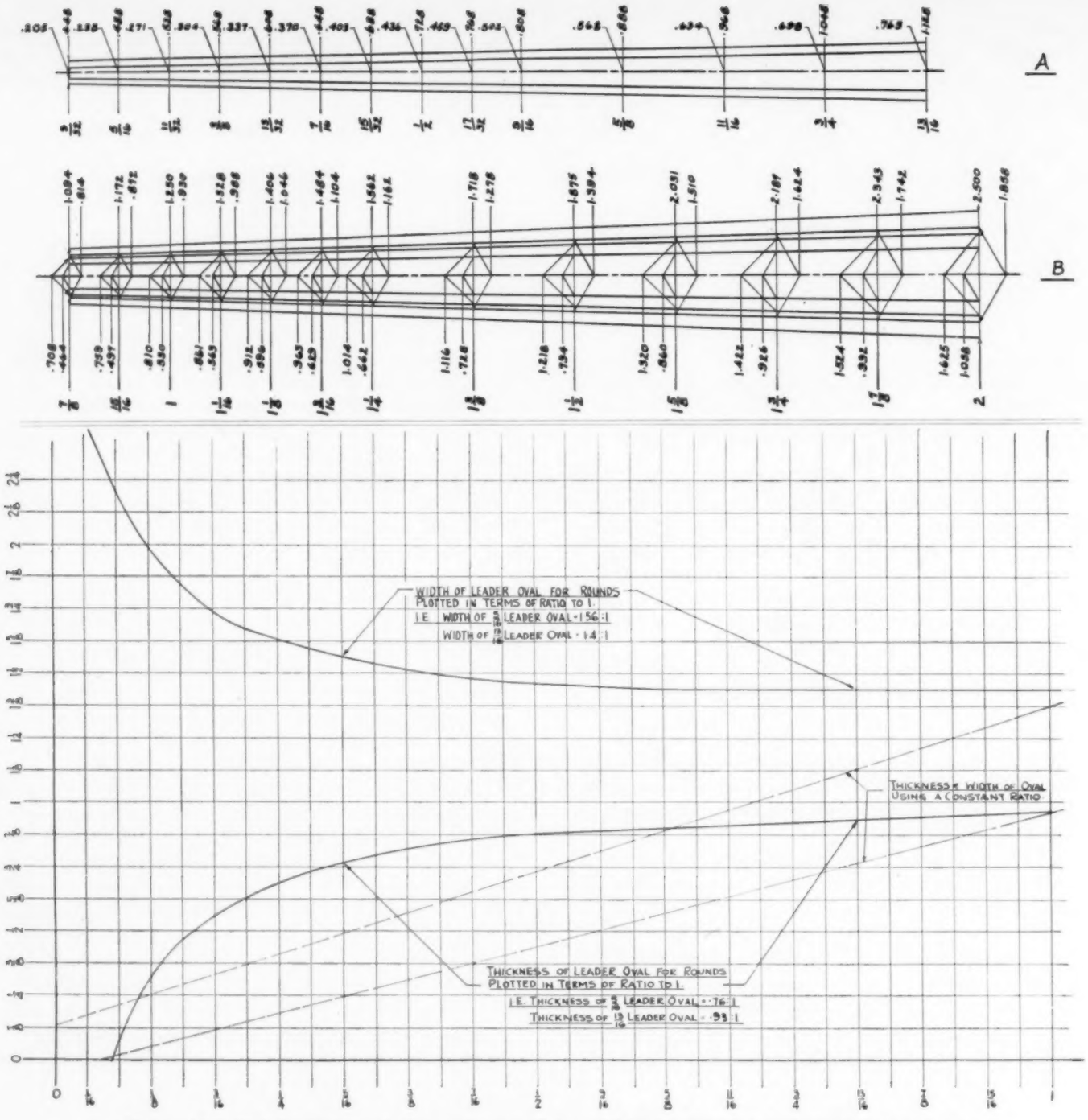

A
B
WIDTH OF LEADER OVAL FOR ROUNDS PLOTTED IN TERMS OF RATIO TO 1.
I.E. WIDTH OF 5/16 LEADER OVAL = 1.56 : 1
WIDTH OF 13/16 LEADER OVAL = 1.4 : 1
THICKNESS & WIDTH OF OVAL USING A CONSTANT RATIO
THICKNESS OF LEADER OVAL FOR ROUNDS PLOTTED IN TERMS OF RATIO TO 1.
I.E. THICKNESS OF 5/16 LEADER OVAL = .76 : 1
THICKNESS OF 13/16 LEADER OVAL = .93 : 1

Figure 14 — This basic formula for ovals on a 10-in. mill leader pass is simple and quite accurate. Curves on bottom were developed for convenience in using.

rolled from one leader pass. As a basis for size ranges, oval leaders should advance as follows: Up to ½ in. by thirty-two seconds, over ½ to 1¼ in. by sixteenths, over 1¼ to 2 in. by eighths, over 2 to 3 in. by fourths, over 3 to 4 in. by ⅜-in. increments, and over 4 in. by ½-in. increments.

Intermediate sizes should be rolled from the next size smaller. There is no definite theory as to when a double radius oval should be used.

However, they are easier to hold up in the finishing pass on large sizes where a blunt oval is used and allow more uniform roll wear.

Keeping in mind, the smaller the size, the greater the spread, a flat oval is used to take care of this condition. The size of square required to fill the leader will remain constant, and a square 1.602 to one will be quite adequate.

ROUND FORMERS

Round formers are just as the word implies—the pass that starts to form the finished round, see Figure 16. The maximum size alloy steel round that can be made before a former pass becomes necessary is a matter of roll strength. Apart from that, there is the question of a clean surface and uniformity of the finished size.

For rolling alloy and tool steels, it is good practice

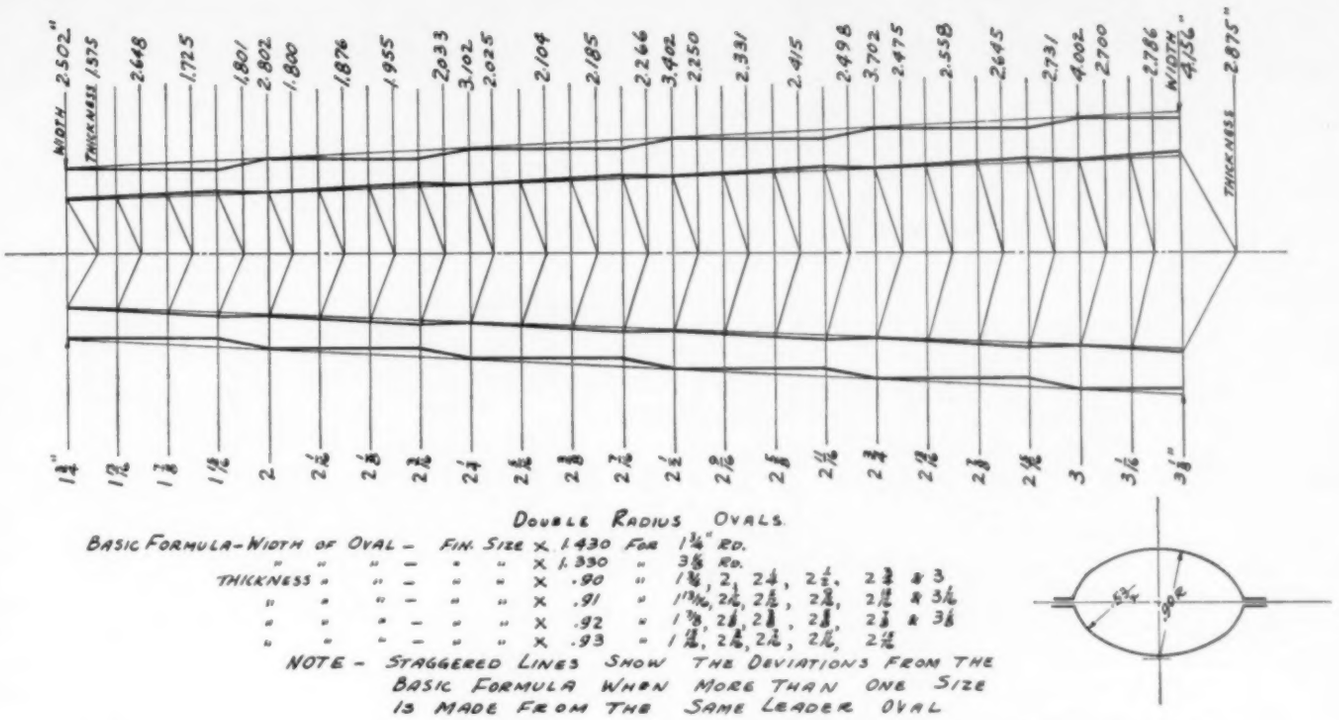

DOUBLE RADIUS OVALS
BASIC FORMULA-WIDTH OF OVAL — FIN. SIZE X 1.430 FOR 1¾" RD.
" " " — " " X 1.330 " 3⅝ RD.
THICKNESS " " — " " X .90 " 1⅜, 2, 2¼, 2½, 2¾ & 3
" " " — " " X .91 " 1 11/16, 2⅛, 2⅜, 2⅝, 2⅞ & 3⅛
" " " — " " X .92 " 1⅝, 2⅛, 2⅜, 2⅝, 2⅞ & 3⅛
" " " — " " X .93 " 1½, 2⅛, 2⅜, 2⅝, 2⅞
NOTE - STAGGERED LINES SHOW THE DEVIATIONS FROM THE BASIC FORMULA WHEN MORE THAN ONE SIZE IS MADE FROM THE SAME LEADER OVAL

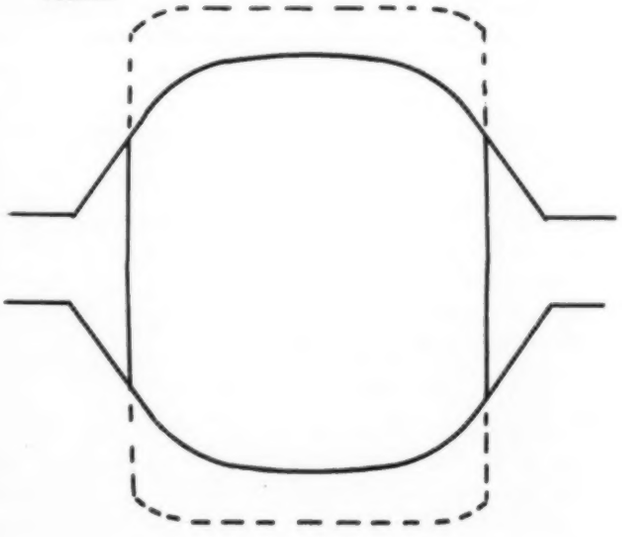
Figure 15 — This formula for double radius ovals on a 16-in. mill leader pass is limited to one size of mill.

to use a former pass for all sizes over $1\frac{3}{16}$ in. diam.

Any formula for designing a round former could possibly be related to the leader pass, but for simplicity is better when related to the finishing pass. Whether the former is used in conjunction with a blunt oval or a flat oval is only a matter of roll adjustment rather than any change in basic design.

The most important thing about a round former is that it must be designed so that the greatest draft will be at the shoulders of the leader, otherwise the bar will turn over. Figure 17 is somewhat exaggerated and more pronounced than actual rolling practice.

Figure 16 — The round former starts to form the finished round.

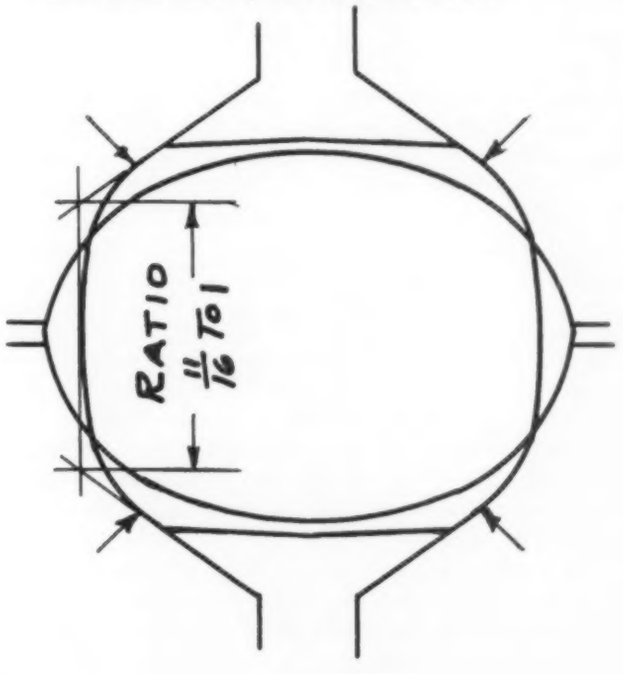


ROUND FORMER

If you superimpose a former design over any given leader pass as shown, you will be able to establish three main dimensions: height, width of facet, and the angle of opening. The two radii are only a matter of making a uniform contour for entering the leader.

If the width of the facet is established with a ratio of $1\frac{1}{16}$ to one, you will find that this same ratio can be

Figure 17 — Round former must be designed so that greatest draft is at the shoulders of the leader.



ROUND FORMER AND LEADER PASS

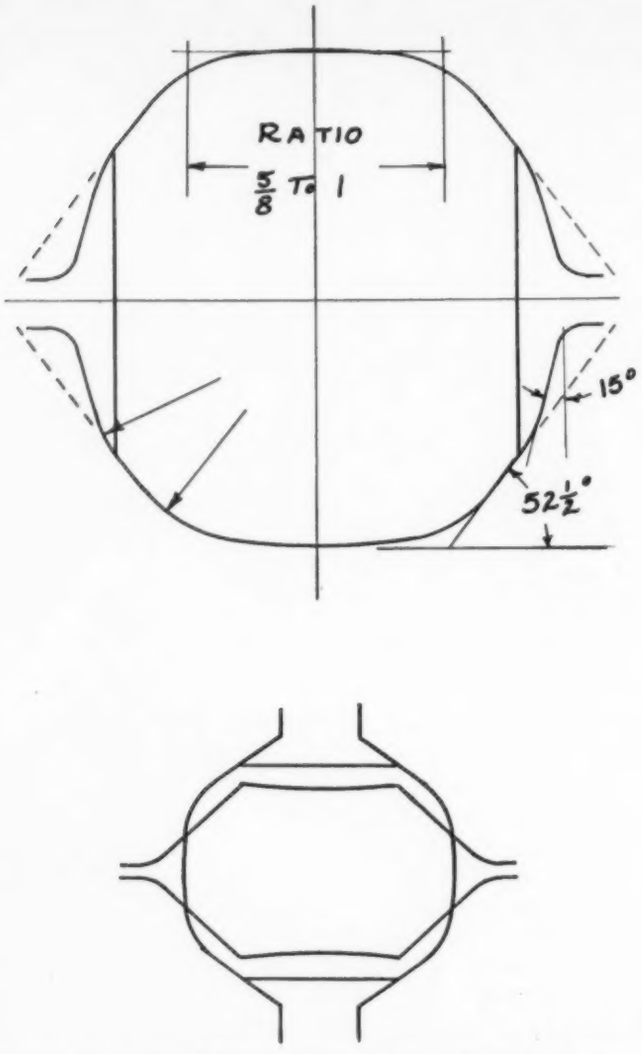


Figure 18 — Round former shown is used to form a hexagon.

carried through a range of sizes from 7/8 to 3-in. For sizes over 3 to 8-in., a ratio of 5/8 to one can be used. The height may change depending on dimensions of the leader oval and will only be a matter of adjustment. The angle of the opening may also change but only to the extent of conserving roll space or when used to form hexagons. See Figure 18.

When it becomes desirable or practical to use a former pass, then of course, the question arises: "What size square is required to start to form the round?" At this point, a little broader aspect of basic design has to be considered. On a mill strictly confined to low tonnage of a wide range of products, where open square roughing, and oval and square intermediate design is used, selecting a square based on any formula is not too much of a problem.

When rolling electric furnace alloy steels and reasonably high production has to be maintained, then the distribution and number of passes required to produce a finished round becomes a vital part of the mill operation. Normally, one can flat, edge, leader pass and finish alloy steels from a square with a ratio of $1\frac{3}{16}$ to one and as much as $1\frac{7}{16}$ to one. On this basis alone, with only minor adjustments, 1 to $1\frac{3}{16}$-in. round can be made from the same roughing or intermediate square,

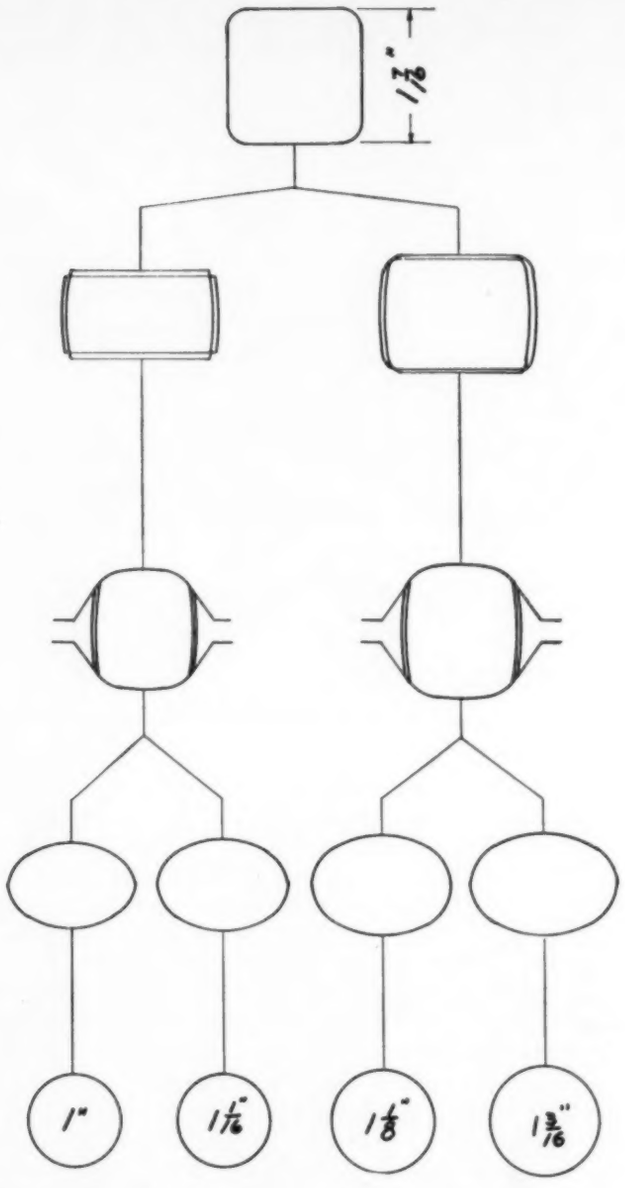


Figure 19 — Pass sequence used to reduce from $1\frac{7}{16}$-in. squares to rounds from 1 to $1\frac{3}{16}$ in. diameter.

as shown in Figure 19. Following this same principle for larger sizes, one can use a $2\frac{1}{4}$-in. square to make a $1\frac{9}{16}$ to $1\frac{11}{16}$-in. round.

Here again, one is faced with another problem, that of taking over 5/8-in. draft in one flat pass on 10-in. rolls before entering the former pass. To avoid the hazard of roll breakage, two flat passes are used and $1\frac{9}{16}$ to $1\frac{11}{16}$-in. rounds are made without any changes in the roughing line as shown in Figure 20.

HAND SQUARES

Hand square rolls constitute a range of finishing passes of standard increments, similar to that used for rolling hand rounds as shown in Figure 21. To cover standard sizes, the rolls are usually designed with an included angle of 90 degrees 30 min with the following increments, up to 2 in. by sixteenths, over 2 in. up to 3 in. by eighths, and over 3 in. by fourths. Figure 21 shows a range of sizes from $1\frac{5}{16}$ to $2\frac{1}{2}$-in.

A formula for opening is to open up the sides above

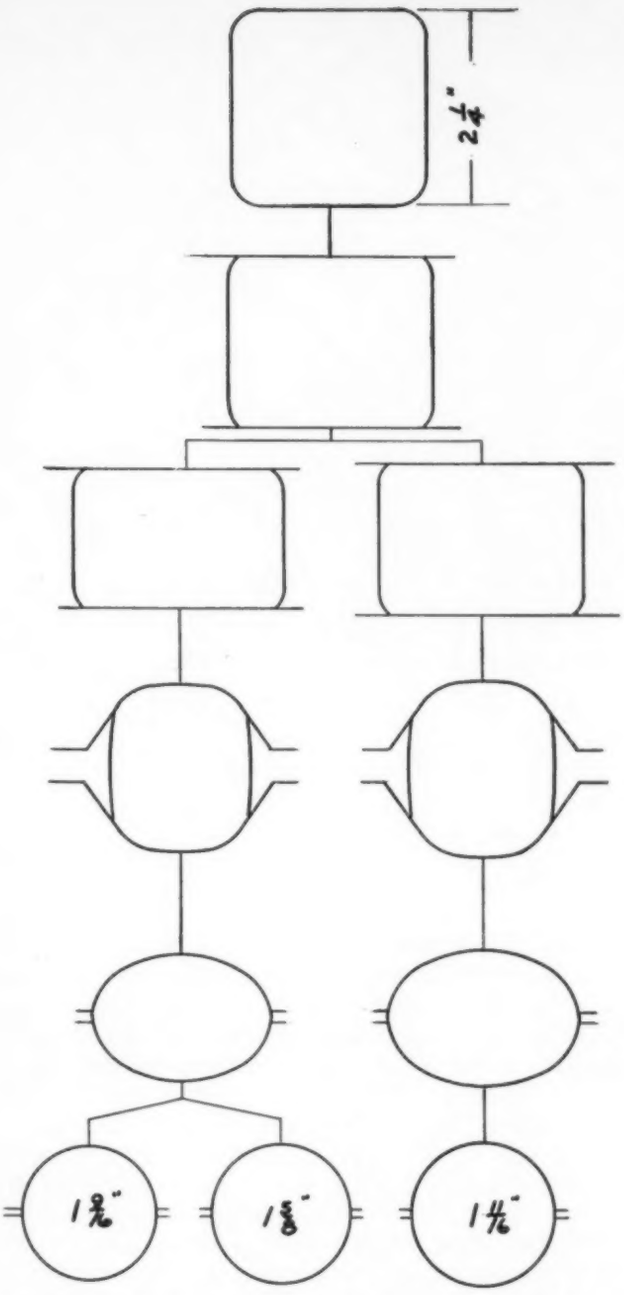


Figure 20 — Sequence of passes used to reduce 2¼-in. squares to 1⁹⁄₁₆-in. and 1¹¹⁄₁₆-in. diameter rounds.

one-half of the diagonal distance, and use a radius equal to the diagonal, as shown in Figure 22.

The opening and corner radii are not too critical and adhering strictly to the above formula would require many templates and tools. Figure 23 shows a much simpler method involving only three tools and three templates covering all sizes up to 4-in.

Hand squares are rolled by simply selecting an open square large enough to fill the third pass larger than the finished size. The bar is turned 90 degrees after each pass and finished by passing through the finishing pass two or three times.

GUIDE SQUARES

The finishing rolls for guide squares must be designed to practically run together to insure sharp corners. When laying out a diamond leader pass, there are at least two methods which can be used. Figure 24 shows one method whereby the diamond is drawn over a circle equal to the size of the finished square. In this case, it is not necessary to make any allowance for running room and will apply to any angle. Figure 25 shows the same diamond leader where the distance across has a ratio of 1.060 to one in which case running-room allowance will have to be made.

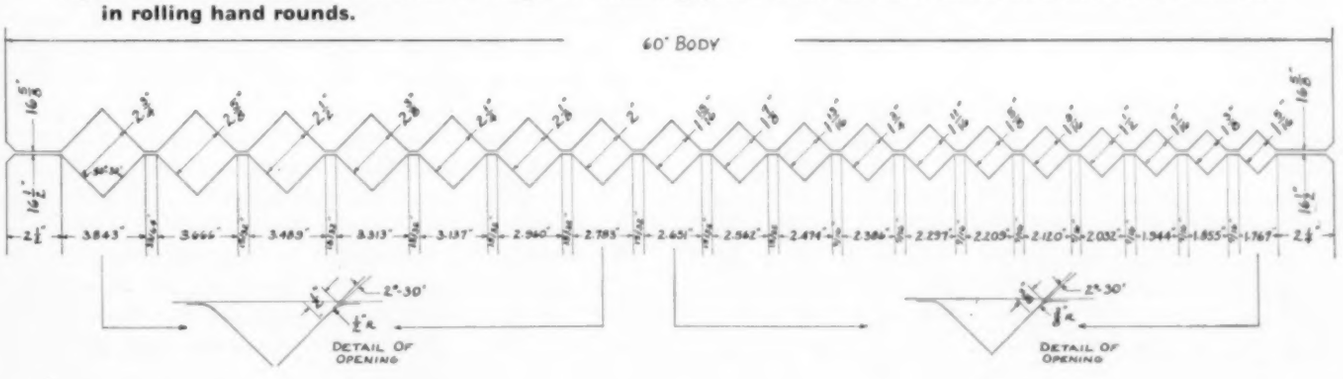
Following the same procedure as used for the aforementioned standard sections, flat leaders are used for small sizes and gradually changing to a blunt leader. Figure 26 shows a range of sizes $^{9}/_{32}$ to 1¼ in., using 112 degrees, up to $^{9}/_{16}$ in., 110 degrees, over $^{9}/_{16}$ to ¾ in., 108 degrees for $^{13}/_{16}$ to $^{15}/_{16}$ in., 106 degrees for 1 in. to 1¼ in. The short diagonal of the diamonds have a ratio of 1.20 to one for $^{9}/_{32}$ in. and gradually increasing to 1.34 to one for 1¼-in. square.

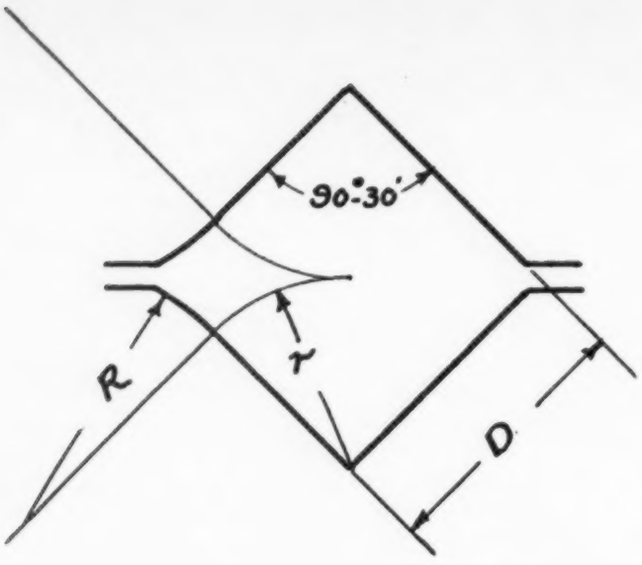
For rolling alloy steels, the leader pass should have radius corners, not only to help develop sharp corners but also to take care of variation of spread in different grades. The size of square required to fill the diamond leader can be figured on the basis of 1.250 to one of the finished size, but this ratio may vary somewhat depending on the corner radius of the initial square.

Former square and diamond passes are required for large sizes as a means of developing sharp corners. As mentioned earlier, the corner radius of the roughing and intermediate diamond and square passes for rolling alloy steels are quite large.

Therefore, it is a matter of individual rolling practice when former passes are required. A 94-degree former square 1.490 times the finished size can be considered normal and the former diamond pass need not exceed 104 degrees.

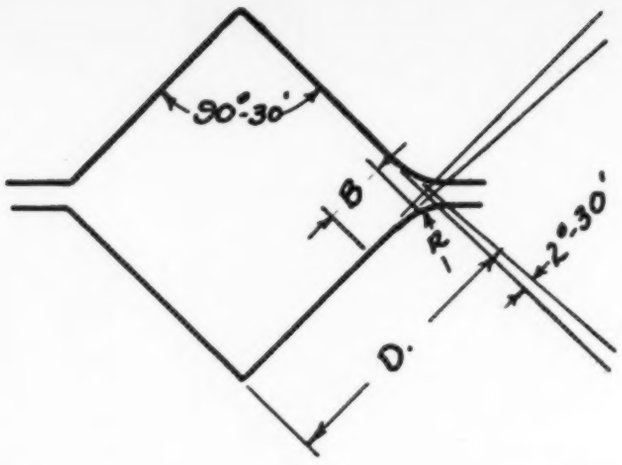
Figure 21 — Hand square rolls for a range of finishing passes with standard increments similar to those used in rolling hand rounds.





HAND SQR. OPENING
R = D
r = ½ DIAGONAL

Figure 22 — One method of opening is to open the sides above one-half the diagonal distance using a radius equal to the diameter.



HAND SQR. OPENING
UP TO 2" DIA. - B = 3/8" R = 3/8"
OVER 2" UP TO 3" DIA. - B = 1/2" R = 1/2"
" 3" " " 4 " - B = 3/4" R = 3/4"

Figure 23 — Method for hand square opening shown is simpler than that given in Figure 22.

At this stage, sharp corners should be avoided, therefore, the ratio of the former diamond and square to one another and to the leader diamond can best be established by superimposing one on the other and making allowances for the bottom radius.

There are some nickel alloy steels where the initial flat and edge passes used for removing furnace scale are not sufficient to insure a clean finished square, and intermediate flat and edging becomes necessary.

SQUARE EDGES AND ROUND EDGE FLATS

Alloy steel flats are rolled for many uses and in a wide range of sizes and grades, for cutting tools, dies, machine parts, ornamental work, etc. Before any definite layout or design can be made, mill capacities must be established.

Generally speaking, the width of the flat is the determining factor and on this basis should not exceed 40 per cent of the nominal pitch diameter on a 3-high mill. Exceptions can be made, but only with full knowledge of the grade involved and roll strength. Minimum widths can be established by using a factor of, thickness plus width not less than about 10 per cent of pitch diameter.

With the above capacities established, minimum and maximum thickness will have to be determined, and on a 10-in. mill equipped with 16-in. roughing, the maximum thickness will establish itself from the maximum billet rolled, providing the width is kept within 40 per cent of the pitch diameter of the finishing mill.

Establishing a minimum thickness formula becomes practically impossible, simply because of the grades involved.

In order to produce a square edge flat of alloy steel, with few exceptions, three edging passes should be used. The amount of draft required between each edging pass can also be established, however, if a definite ratio of draft were established and strictly adhered to, too much time would be used in pass changes and little time left for rolling. For practical purposes, one should not have less than 8 per cent draft and seldom exceed 20 per cent from leader edging to the finishing pass, likewise for the proceeding flat and edge work.

Since the width of a flat is easily controlled by screw adjustment, it only remains a problem of proper design and width of the various edging passes.

Edging passes are divided into three types namely; shallow, deep and plain, and warrant some explanation at this time.

When one has established the minimum and maximum width that can be rolled on any particular mill, one will also find that the vertical roll adjustment has its limitations and seldom exceeds 20 per cent of the pitch diameter. It can readily be seen that a flat ¼ x 4-in. could not be rolled in the same edging pass as ¼ x 1-in. on a 10-in. mill. Therefore, different depths of edging of the same width are required to cover a normal range of widths. This same condition arises when edging on plain rolls and is taken care of by merely using a stepped roll, both of which are shown on Figure 27.

Whether one designs his rolls with shallow and deep edging, of the same width, side by side, or in separate rolls, is more or less a matter of choice, but from the standpoint of roll strength alone, they should be in separate rolls of different physical properties.

All edging passes require crowning for developing sharp corners in the initial edging and allowance for spread in the finishing pass, the amount of crown or

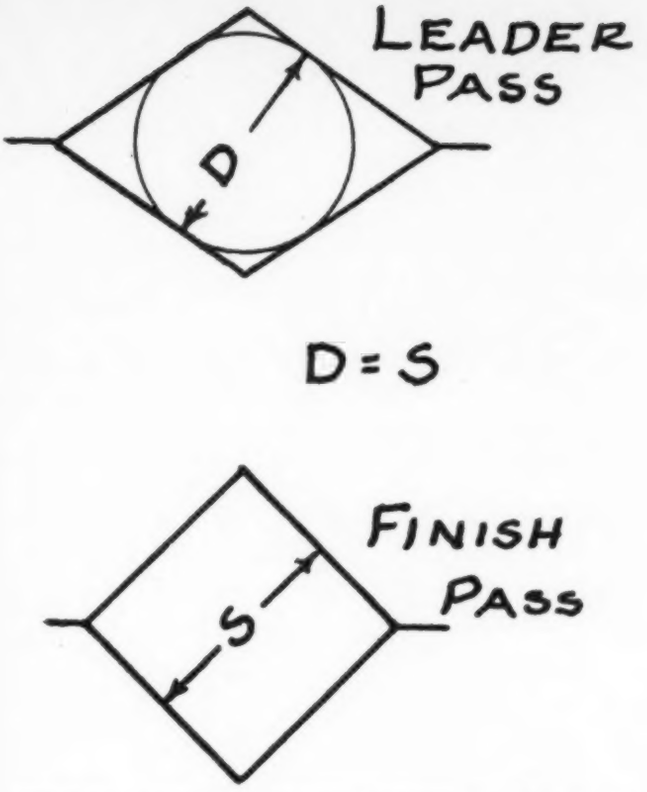


Figure 24 — In this typical method of laying out a diamond leader pass, the diamond is drawn over a circle equal to the size of the finished square.

convex can be indicated by either radius or depth. A formula indicating depth in relation to the width of edging pass in question is most desirable.

Taper or clearance is also required and the degree of taper should be consistent and also have some relation to the depth.

When the depth is not more than one and one-half times the width, use 10 degree taper, up to three times the width use 7 degrees, and over three times the width use 5 degrees.

Flats where the width is not more than one and one-half times the thickness, are generally called near squares and have to be made somewhat differently than a wider flat. In this case, it is necessary to form the corners by means of a fluted square, flattening only once or twice, and using only one edging pass either closed or on plain rolls.

Figure 28 shows diamond and fluted square method used, also open fluted square design for large sizes. It also shows formula which is used to determine fluted square required for a given size near square.

Plain edging rolls are being used and are becoming more popular for rolling stainless flat rolled products. Used in conjunction with roller entry guides, they have done a lot to relieve the problem of producing flats for ornamental work.

A fairly accurate formula can be used to determine a suitable square for starting the initial flat work, and of course, will vary somewhat according to the number and type of edging passes, size of mill and grade.

When a workable formula has been established, all sizes should be worked out and charted for use by the rollers for quick reference.

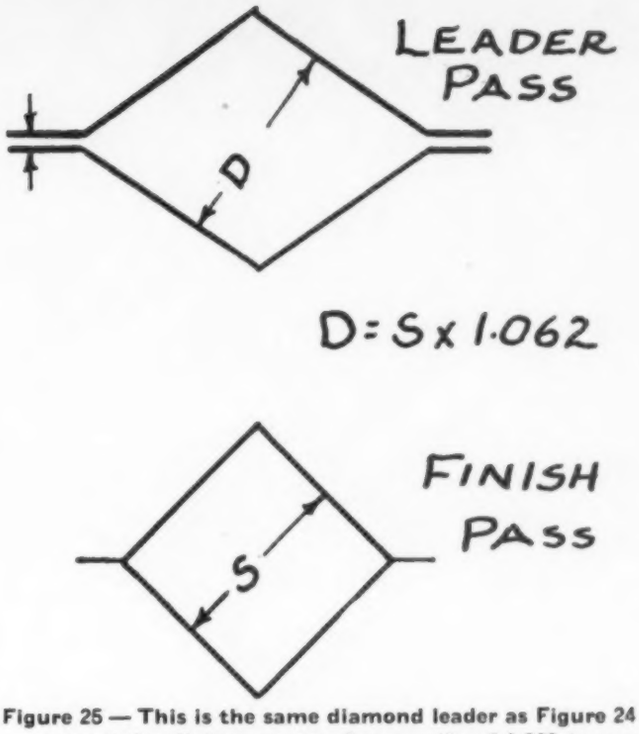


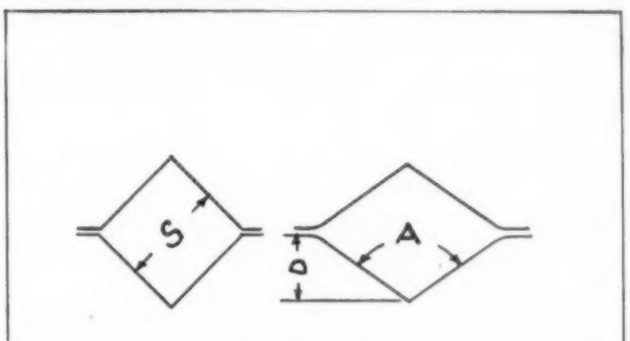
Figure 25 — This is the same diamond leader as Figure 24 except the distance across has a ratio of 1.060 to one necessitating running-room allowance.

OCTAGONS

With a few exceptions, octagons are rolled to a rather small range of sizes, and generally confined to tool steel grades ¼ to 1½ in. diameter.

When using the most popular flat and open side method of rolling, first consideration should be given to the shrinkage allowance for the finishing pass. There should be a clear understanding as to whether one is going to roll to the AISI tool steel or the AISI hot rolled alloy steel tolerances. Tool steels are usually finished at much lower temperatures than most alloy

Figure 26 — Range of leader diamond dimensions for 9/32 to 1¼-in. openings.



S	D	A°	S	D	A°	S	D	A°
9/32	.155	112°	1/2	.285	112°	7/8	.560	108°
5/16	.174	"	17/32	.309	"	15/16	.600	"
11/32	.192	"	9/16	.327	"	1	.630	106°
3/8	.211	"	5/8	.374	110°	1 1/16	.676	"
13/32	.229	"	11/16	.409	"	1 1/8	.723	"
7/16	.247	"	3/4	.448	"	1 3/16	.765	"
15/32	.266	"	13/16	.510	108°	1 1/4	.807	"

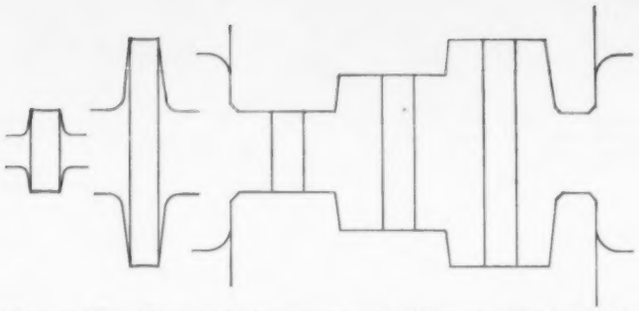


Figure 27 — Two edging passes of different depths with same thickness of flat and step rolls for plain edging are given.

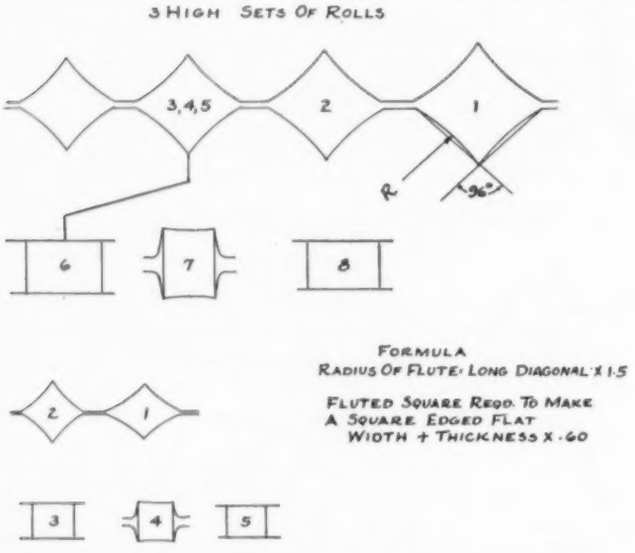


Figure 28 — Sketches show diamond and fluted square method which are used to reduce to near squares.

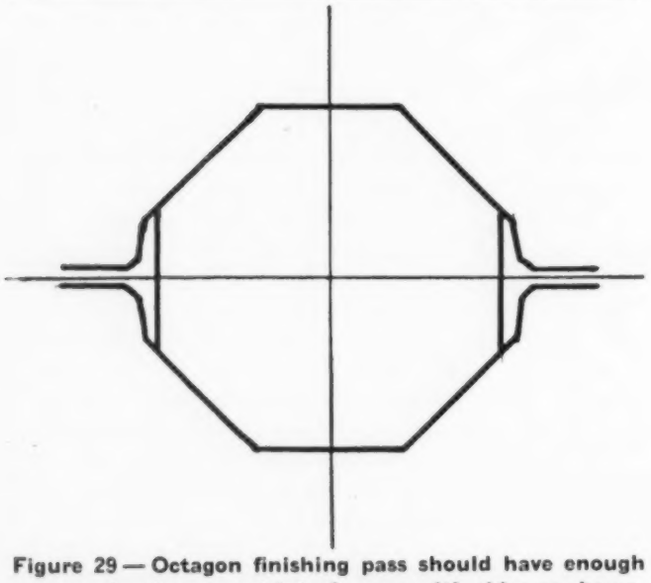


Figure 29 — Octagon finishing pass should have enough opening to prevent interference with sides as shown.

steels, and regardless of finishing temperature, the roller will have to roll to the full allowance made in order to produce a uniform section. The amount of clearance or opening is not critical and should be sufficient to prevent any interference with the sides as shown in Figure 29.

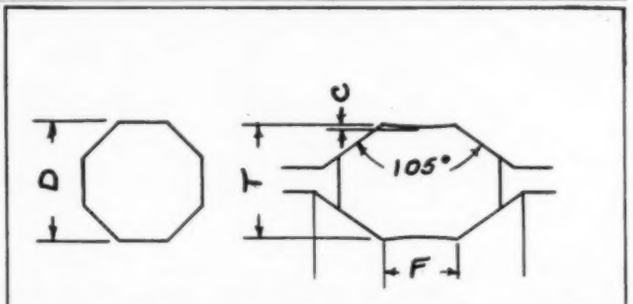
Running-room allowance can be figured on the basis of $\frac{1}{32}$ for sizes up to $\frac{1}{2}$ in.; over $\frac{1}{2}$ to 1 in. by sixteenths; and over 1 in., by eighths.

When figuring a leader pass, there are two known quantities within the finished bar, namely, diameter and length of the side or facet, and it is only a matter of choice which will be used in developing a formula.

Regarding the angle of the sides, this to, is not too critical. Octagon leaders have been designed with an included angle of 90 to 120 degrees, but for convenience of the entry guide equipment, the angle should correspond to the angle of the entry guides for guide rounds.

With this in mind and considering that 105 degrees is used for round finishing guides, then this same angle will be quite satisfactory for the octagon leader pass, thus eliminating special entry guide equipment.

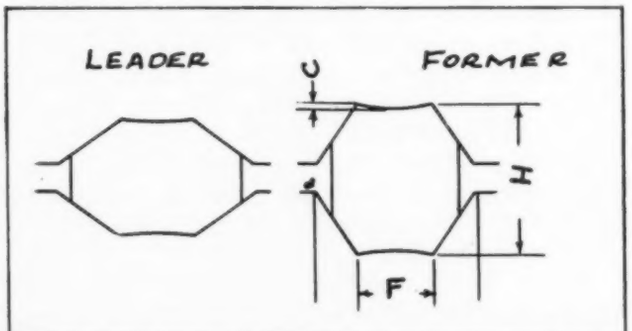
To produce a bar with sharp corners, it has been found necessary to make the facet about 50 per cent wider than that of the finished bar for a 105 degree



D	F	T	C	D	F	T	C
$\frac{1}{4}$	.156	.230	.007	$\frac{3}{4}$	.469	.690	.020
$\frac{5}{16}$	.195	.287	.008	$\frac{13}{16}$	.507	.747	.022
$\frac{3}{8}$	.234	.345	.010	$\frac{7}{8}$	.547	.805	.024
$\frac{7}{16}$	.273	.402	.012	1	.625	.920	.027
$\frac{1}{2}$	.312	.460	.014	$1\frac{1}{8}$	.703	1.035	.030
$\frac{9}{16}$	.351	.517	.015	$1\frac{1}{4}$	.781	1.150	.033
$\frac{5}{8}$	.390	.575	.017	$1\frac{3}{8}$	.859	1.265	.037
				$1\frac{1}{2}$	.937	1.380	.040

Figure 30 — Leader pass design for octagons from $\frac{1}{4}$ to $1\frac{1}{2}$ in.

Figure 31 — Octagon former pass dimensions from $\frac{7}{8}$ to $1\frac{1}{2}$ in.



SIZE	F	H	C	SIZE	F	H	C
$\frac{7}{8}$	.547	1.039	.034	$1\frac{1}{4}$	.781	1.600	.050
1	.625	1.280	.040	$1\frac{3}{8}$	.859	1.760	.054
$1\frac{1}{8}$	.703	1.440	.045	$1\frac{1}{2}$	.937	1.920	.060

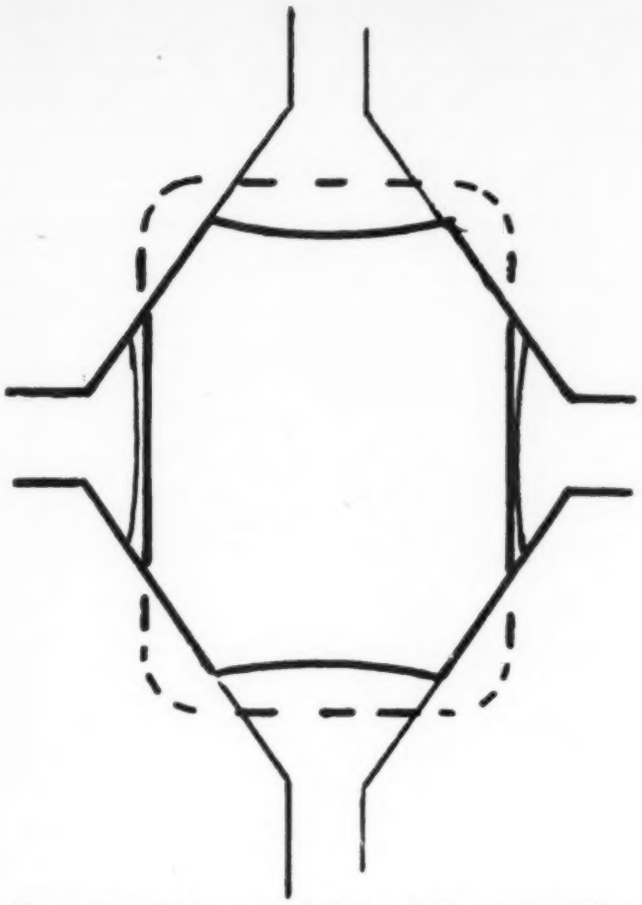


Figure 32 — Former pass design is filled out to width of leader facet.

leader or a formula of 0.625 to one. Figure 30 shows the details using the above formula. It is also necessary to have the facet convexed to allow for spread, and this can be indicated by either radius or depth. A formula indicating depth is most desirable because alterations can easily be made by simple measurement. The above design shows a convex ratio of 0.027 to one.

The sizes requiring a former pass, correspond with former requirements for rounds and hexagons which, when rolling alloy and tool steels, are all sizes over $^{13}/_{16}$ in. diam.

The design of the former should be such as to allow the bar to ride perfectly through the leader. This can be accomplished by having the angle of the sides corresponding to the angle of the leader. If the leader pass is designed with an included angle of 105 degrees, the former should have an included angle of 75 degrees.

The design of the facet is most important because it not only forms the octagon itself, but also develops the corners.

The facet should be wide enough to take the entering rectangle without too much pinching and have enough convex so that there will not be any convex on the sides after going through the leader pass. Figure 31 shows a former with facets 0.625 to one or the same as the leader facet, and convex 0.040 to one, also a height of 1.280 to one.

Any additional forming, although sometimes used is hardly necessary because of the limited range of sizes involved. The size of the initial square required for the above former, is 1.310 times the finished size, and

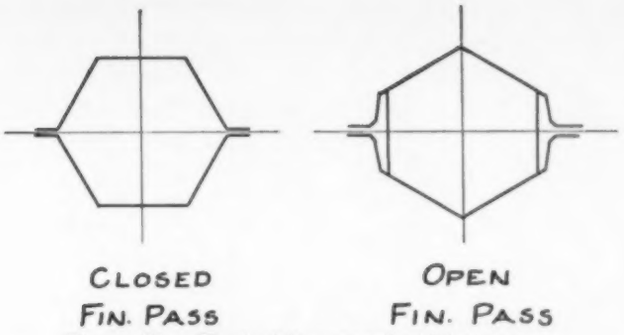


Figure 33 — Typical hexagon finishing passes.

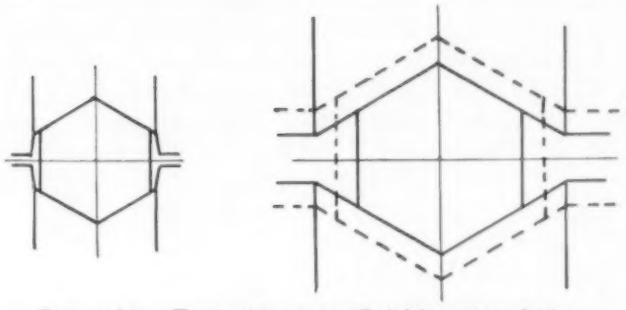


Figure 34 — Typical hexagon finishing pass design.

should be flattened so that the sides of the former will fill out to the width of the leader facet or slightly more as shown in Figure 32.

HEXAGONS

Hexagons, while not required in as wide a range of sizes and grades as rounds, still are called for in about the same increments up to about 3 in. diameter.

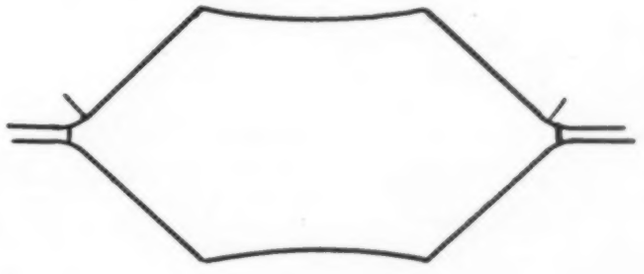
There are two ways to finish a hexagon bar, on the flat and on the corners, each requiring a different design for preceding passes as shown in Figure 33.

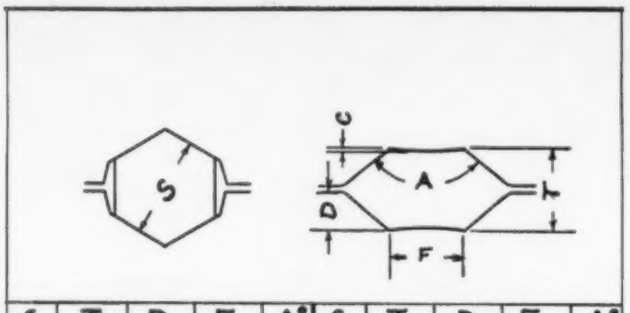
Since most alloy steels are finished with the corners up and down with open sides, formulas to follow will be confined to this method of rolling.

As far as shrinkage and tolerance allowances are concerned, there is no problem in the finishing pass design. Sizes up to about 1-in. diameter are usually made in a somewhat closed pass with sufficient side clearance using the same running room as used for rounds. Sizes over 1-in. are commonly made by simply using a diamond with 120-degree angle and making proper adjustment of the rolls for each size. The above designs are shown in Figure 34.

Leader pass designs for hexagons are somewhat varied and can be compared with those for rolling rounds. A leader with an included angle of 70 to 80

Figure 35 — It is necessary to fill the leader in order to develop sharp corners.

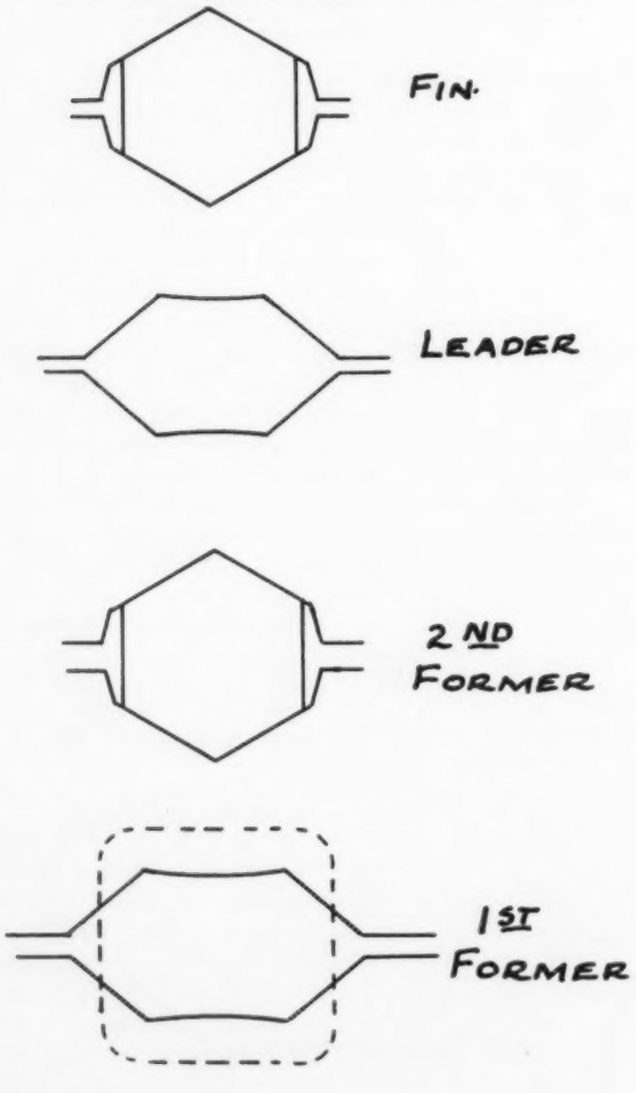




S	T	D	F	A°	S	T	D	F	A°
1/4	.190	.080	.175	102°	1	.840	.390	.770	100°
5/16	.239	.104	.218	"	1 1/8	.960	.440	.866	"
3/8	.290	.130	.263	"	1 1/4	1.084	.501	.962	"
7/16	.341	.155	.320	"	1 3/8	1.172	.537	1.058	95°
1/2	.394	.182	.375	"	1 1/2	1.317	.608	1.155	"
9/16	.446	.205	.418	"	1 5/8	1.426	.663	1.251	"
5/8	.501	.235	.462	"	1 3/4	1.536	.718	1.347	"
11/16	.552	.246	.511	100°	1 7/8	1.646	.773	1.444	"
3/4	.608	.274	.560	"	2	1.656	.828	1.540	"
13/16	.664	.302	.608	"					
7/8	.722	.331	.657	"					
15/16	.780	.360	.711	"					
FOR 1/4" C = S x .024 FOR 1" C = S x .014									

Figure 36 — Dimensions for hexagon leader pass design.

Figure 37 — Former, leader, and finish pass design for hexagons over 13/16 in. diameter.



degrees and a wide facet is similar to a blunt oval, and one with an included angle of 100 degrees and more with narrow facet compares with a flat oval leader.

Like the leader oval for rounds, the hexagon leader must have a definite relationship to the finished bar. Consideration must be given to the range of finished sizes to be rolled from each leader, the size of the mill and also the increasing arc of contact as sizes increase.

A workable formula does not need to allow for running room but it will be found necessary to run the rolls close together and particular attention must be paid to the depth of the pass and collar radius.

It is necessary to fill the leader almost to the extent of overfilling in order to develop sharp corners and the collar radius must be uniform, as shown in Figure 35.

By adding one-third to the side of a 1-in. diam hexagon and using this dimension for the facet, one arrives at a formula of 0.770 to one, and for thickness use a ratio of 0.840 to one. Then using an included angle of

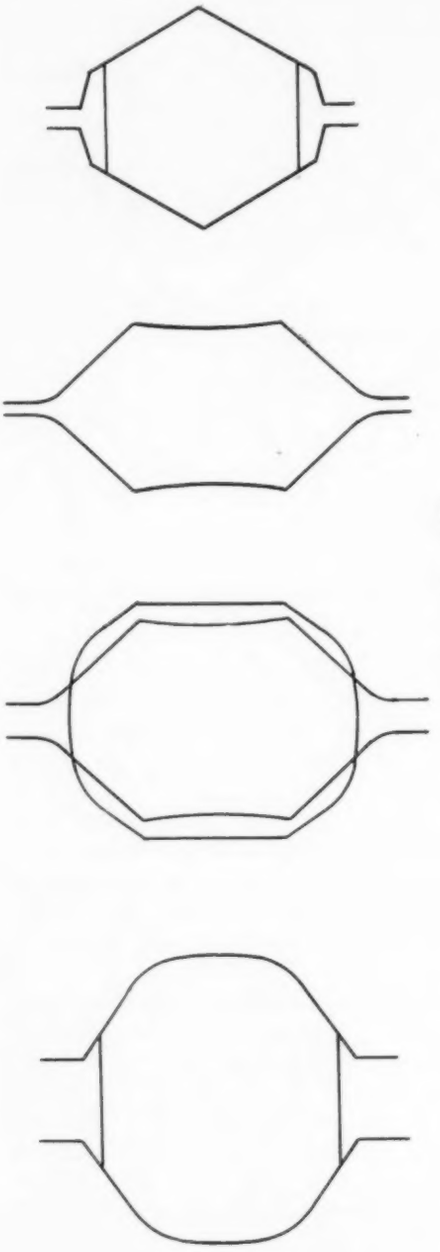


Figure 38—Round former and typical leader passes for rolling sizes from 1¼ in. diameter hexagon on a 10-in. mill.

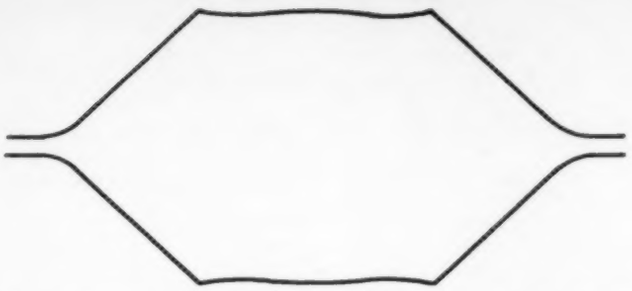


Figure 39 — Combination concave and convex facet is required when rolling large sizes on a small mill.

100 degrees, one will have the basis for his leader design. Taking into consideration the increasing arc of contact as the sizes increase, one could, more or less, maintain a constant arc. For simplicity, Figure 36 shows a range of leader passes of 102 degrees up to $\frac{5}{8}$-in. diam, 100 degrees up to $1\frac{1}{4}$-in. diam, and 95 degrees for $1\frac{3}{8}$ to 2 in. For the facet, a ratio of 0.70 to one is used for $\frac{1}{4}$ in. and gradually increases to 0.770 to one for 1-in. and over. A ratio for thickness is 0.760 to one for $\frac{1}{4}$ in., gradually increasing to 0.867 for $1\frac{1}{4}$ in., and 0.878 in. for over $1\frac{1}{4}$ in.

As mentioned before, it is considered good practice to start using a former pass for rounds on sizes over $1\frac{3}{16}$ in. diam and the same theory applies to hexagons. There are a number of designs used such as shown in Figure 37, all of which play a part in rolling hexagons.

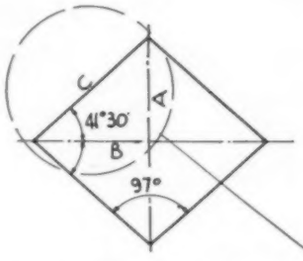
On a mill, where tonnages are small and size and grades are varied, a round former as previously shown in Figure 17 can also be used for forming hexagons, except that one use the $1\frac{1}{8}$-in. round former to make a 1-in. hexagon, reasons for which will be explained a little later.

The first and second former design shown on Figure 37 have been tried for rolling alloy steels, but the drafts were found to be too heavy on the first two passes, particularly on a 10-in. mill and had to be abandoned.

The size of the square required to start forming a hexagon is somewhat larger than that used for the same size round mainly because the leader has to be filled and corners have to be developed. The square required to fill the leader can be figured on the basis of 1.380 to one on sizes up to and including $1\frac{3}{16}$-in. diam. As mentioned before it requires a $1\frac{1}{8}$-in. round former to make a 1-in. hexagon, therefore, the square would be relatively larger and a ratio of 1.40 to one should apply.

Flattening the square before edging into the former does not necessarily require any formula and this needs to be only about one-sixteenth over the finished size to make a flat side in the former that matches the leader facet, as shown in Figure 18.

Figure 40 — Typical example of computing passes is shown in this design computation.



LAYOUT OF 4" OPEN SQUARE.
AREA OF 4×4 SQUARE = 16 SQ.IN.
REDUCTION IN AREA - 18% OF EACH PASS = 82% OF EACH PRECEDING PASS.

METHOD OF USING LOGARITHMS

MULTIPLICATION: TO MULTIPLY USING LOGS. ADD LOGS OF EACH NUMBER TO BE MULTIPLIED.

DIVISION: SUBTRACT LOG OF DIVISOR FROM LOG. OF NUMBER TO BE DIVIDED.

SQUARE ROOT: LOG OF NUMBER DIVIDED BY 2.

EXAMPLES

MULTIPLICATION: TO MULTIPLY 2×4 = 8
LOG OF 2 = ·30103
LOG OF 4 = ·60206
·90309
ANTILOG ·90309 = 8 ANS.

DIVISION: TO DIVIDE 4 BY 2 = 2
LOG OF 4 = ·60206
LOG OF 2 = ·30103
·30103
ANTILOG ·30103 = 2 ANS.

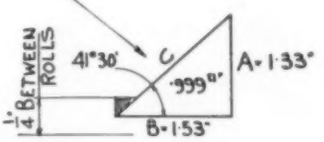
SQUARE ROOT: SQUARE ROOT OF 16 = 4
LOG OF 16 = 1·20412
∴ 1·20412 ÷ 2 = ·60206
ANTILOG OF ·60206 = 4 ANS.

NOTE: LOG ·82 = T·91381
T IS OMMITED BELOW.

PASS REDUCTION USING LOGARITHMS.

4" SQ. BILLET = 16 SQ.IN. (AREA)
LOG. 16 = 1·20412

		TOTAL AREA	AREA OF TRIANGLE
LOG ·82 =	·91381		
	·11793 =	13·12 SQ.IN. ÷4 =	3·28 SQ.IN.
LOG. 82 =	·91381		
	·03174 =	10·86 SQ.IN. ÷4 =	2·72 SQ.IN.
LOG ·82 =	·91381		
	·94555 =	8·82 SQ.IN. ÷4 =	2·20 SQ.IN.
LOG ·82	·91381		
	·85936 =	7·234 SQ.IN ÷4 =	1·808 SQ.IN.
LOG ·82	·91381		
	·77317 =	5·932 SQ.IN ÷4 =	1·4803 SQ.IN.
LOG ·82	·91381		
	·68698 =	4·864 SQ.IN ÷4 =	1·216 SQ.IN.
LOG ·82	·91381		
	·60079 =	3·998 SQ.IN ÷4 =	·999 SQ.IN.



SOLVE FOR SIDE "B"

FORMULA = $\sqrt{\frac{\text{AREA} \times 2}{\text{TANG. } 41°30'}} = \sqrt{\frac{·999 \times 2}{\text{TAN } 41°30'}} = \sqrt{\frac{1·998}{\text{TAN } 41°30'}}$

LOG 1·998 = ·30060
LOG TAN 41°30' = ·94681
·35379 = $\sqrt{·35379}$ = ·35379 ÷ 2 = ·17689
B = ANTILOG ·17689 = 1·53" ANS.

SOLVE FOR SIDE "A"

FORMULA = A = B × TAN 41°30'

LOG B = ·17689
LOG TAN 41°30' = ·94681
·12370
A = ANTILOG ·12370 = 1·33" ANS.

TABLE II

Nominal Weight per Foot — Hot Rolled Bars
Rounds, Squares, Octagons, Hexagons

Size, in.	Nominal rolled diam., in.	Weight per foot			
		Rounds	Squares	Octagons	Hexagons
7/32	0.218	0.127	0.162	0.134	0.140
15/64	0.234	0.146	0.186	0.154	0.161
1/4	0.250	0.167	0.212	0.176	0.184
17/64	0.265	0.189	0.238	0.198	0.206
9/32	0.281	0.211	0.268	0.223	0.232
19/64	0.296	0.235	0.299	0.248	0.259
5/16	0.312	0.260	0.331	0.274	0.286
21/64	0.328	0.287	0.365	0.303	0.316
11/32	0.343	0.315	0.400	0.332	0.346
23/64	0.359	0.344	0.438	0.363	0.379
3/8	0.375	0.375	0.478	0.396	0.413
25/64	0.390	0.408	0.517	0.429	0.447
13/32	0.406	0.440	0.560	0.465	0.484
27/64	0.422	0.473	0.605	0.502	0.523
7/16	0.437	0.511	0.651	0.540	0.563
29/64	0.453	0.547	0.698	0.579	0.603
15/32	0.469	0.586	0.747	0.619	0.646
31/64	0.484	0.625	0.797	0.661	0.689
1/2	0.500	0.667	0.850	0.705	0.735
17/32	0.531	0.753	0.958	0.795	0.829
9/16	0.562	0.843	1.074	0.890	0.928
19/32	0.594	0.941	1.198	0.994	1.036
5/8	0.625	1.043	1.328	1.101	1.148
21/32	0.656	1.149	1.463	1.213	1.265
11/16	0.687	1.262	1.607	1.333	1.389
23/32	0.719	1.379	1.756	1.456	1.518
3/4	0.750	1.500	1.912	1.586	1.654
25/32	0.781	1.628	2.074	1.720	1.793
13/16	0.812	1.760	2.242	1.859	1.938
27/32	0.844	1.900	2.420	2.007	2.093
7/8	0.875	2.044	2.603	2.159	2.250
29/32	0.906	2.191	2.790	.....	2.413
15/16	0.937	2.347	2.988	2.478	2.584
31/32	0.969	2.505	3.190	.....	2.758
1	1.000	2.670	3.400	2.820	2.940
1 1/32	1.031	2.84	3.614	.....	3.125
1 1/16	1.062	3.01	3.835	3.180	3.316
1 3/32	1.093	3.19	4.059	.....	3.510
1 1/8	1.125	3.38	4.301	3.567	3.719
1 5/32	1.156	3.57	4.542	.....	3.927
1 3/16	1.187	3.76	4.790	.....	4.142
1 7/32	1.218	3.96	5.04	.....	4.360
1 1/4	1.250	4.17	5.31	4.40	4.59
1 9/32	1.281	4.38	5.58	.....	4.82
1 5/16	1.312	4.60	5.85	.....	5.06
1 11/32	1.344	4.82	6.13	.....	5.30
1 3/8	1.375	5.05	6.43	5.33	5.56
1 13/32	1.406	5.28	6.72	.....	5.81
1 7/16	1.437	5.52	7.02	.....	6.07
1 15/32	1.469	5.76	7.33	.....	6.33
1 1/2	1.500	6.01	7.65	6.34	6.61
1 17/32	1.531	6.26	7.97	.....	6.89
1 9/16	1.562	6.52	8.30	.....	7.17
1 19/32	1.594	6.78	8.64	.....	.....
1 5/8	1.625	7.05	8.98	1.744	7.76
1 21/32	1.656	7.32	9.32	.....	.....
1 11/16	1.687	7.60	9.68	.....	8.37
1 23/32	1.719	7.89	10.04	.....	.....
1 3/4	1.750	8.18	10.41	8.63	9.00
1 25/32	1.781	8.47	10.78	.....	9.32
1 13/16	1.812	8.77	11.16	.....	9.65
1 27/32	1.844	9.08	11.55	.....	9.98

TABLE II — Continued

Nominal Weight per Foot — Hot Rolled Bars
Rounds, Squares, Octagons, Hexagons

Size, in.	Nominal rolled diam., in.	Weight per foot			
		Rounds	Squares	Octagons	Hexagons
1 7/8	1.875	9.39	11.95	9.91	10.33
1 29/32	1.906	9.70	12.35	.....	10.68
1 15/16	1.937	10.02	12.76	.....	11.03
1 31/32	1.969	10.35	13.17	.....	11.39
2	2.000	10.68	13.60	11.28	11.76
2 1/16	2.078	11.52	14.68	.....	12.69
2 1/8	2.141	12.23	15.58	.....	13.48
2 3/16	2.203	12.96	16.50	.....	14.27
2 1/4	2.266	13.71	17.46	14.48	15.10
2 5/16	2.328	14.47	18.42	.....	15.93
2 3/8	2.391	15.26	19.44	.....	16.81
2 7/16	2.453	16.06	20.46	.....	17.69
2 1/2	2.516	16.90	21.52	17.85	18.61
2 9/16	2.585	17.84	22.72	.....	19.64
2 5/8	2.648	18.71	23.84	.....	20.61
2 11/16	2.710	19.61	24.97	.....	21.59
2 3/4	2.773	20.52	26.14	21.68	22.60
2 13/16	2.835	21.44	27.32	.....	23.63
2 7/8	2.898	22.41	28.55	.....	24.69
2 15/16	2.960	23.39	29.79	.....	25.76
3	3.023	24.38	31.07	25.77	26.86
3 1/8	3.148	26.44	33.69	.....	29.13
3 1/4	3.273	28.58	36.34	.....	31.49
3 3/8	3.398	30.81	39.25	.....	33.94
3 1/2	3.523	33.12	42.20	35.00	36.49
3 5/8	3.656	35.69	45.44	.....	39.30
3 3/4	3.781	38.17	48.61	40.31	42.03
3 7/8	3.906	40.74	51.87	.....	44.85
4	4.031	43.38	55.25	45.82	47.77
4 1/8	4.156	46.12	58.72	.....	.....
4 1/4	4.281	48.93	62.31	.....	.....
4 3/8	4.406	51.83	66.00	.....	.....
4 1/2	4.531	54.81	69.80	57.89	60.36
4 5/8	4.664	58.10	73.96	.....	.....
4 3/4	4.789	61.26	77.97	.....	.....
4 7/8	4.914	64.50	82.10	.....	.....
5	5.039	67.79	86.33	71.60	74.65
5 1/8	5.164	71.23	90.66	.....	.....
5 1/4	5.289	74.72	95.11	.....	.....
5 3/8	5.414	78.29	99.66	.....	.....
5 1/2	5.538	81.95	104.31	86.49	90.17
5 3/4	5.812	90.19	114.85	.....	.....
6	6.062	98.12	124.94	103.63	108.04
6 1/4	6.312	106.37	135.46	.....	.....
6 1/2	6.562	114.97	146.40	121.43	126.60
6 3/4	6.828	124.48	158.51	.....	.....
7	7.078	133.76	170.33	141.28	147.29
7 1/4	7.328	143.38	182.58	.....	.....
7 1/2	7.578	153.33	195.25	.....	.....
7 3/4	7.828	163.60	208.34	.....	.....
8	8.078	174.23	221.86	184.02	191.85

Note: Nominal rolled diameters are based on one-half of AISI tolerances and weights figured accordingly.

To overcome the heavy drafts encountered on sizes over 1⅜ in. on a 10-in. mill, another method is used. This is merely to double the leader pass as shown on Figure 38 and to use an initial starting square ratio of 1.50 to one instead of 1.40 to one. Compensation for spread in the finishing must be made in the leader and cannot be treated lightly. On small sizes, a formula in terms of radius can be used but better still, should be

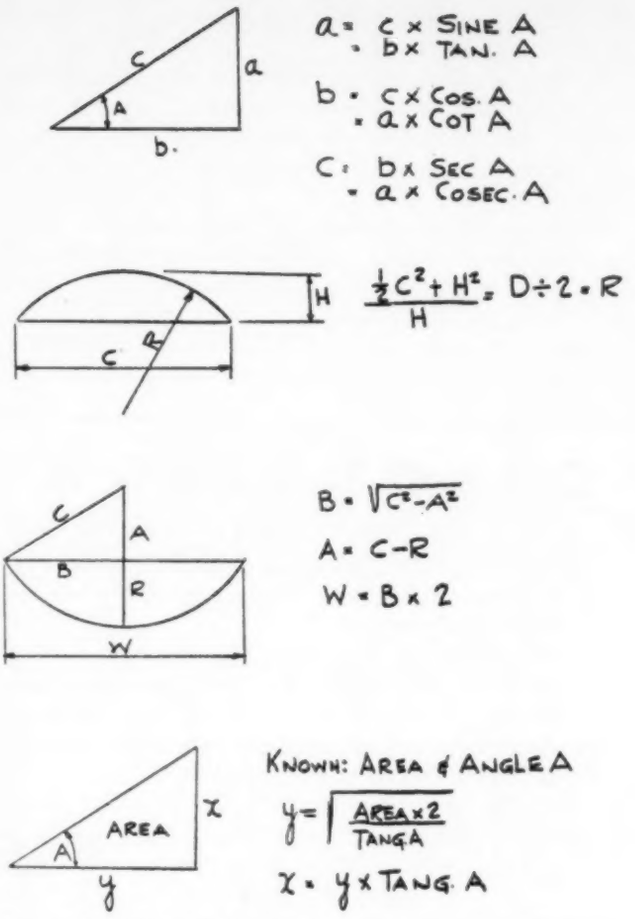

a = c x SINE A
= b x TAN. A
b = c x Cos. A
= a x COT A
C = b x SEC A
= a x COSEC. A
H
½C²+H²/H = D÷2 = R
B = √C²-A²
A = C-R
W = B x 2
KNOWN: AREA & ANGLE A
AREA
y = √(AREA x 2 / TANG A)
x = y x TANG. A

Figure 41 — Trigometrical functions shown are commonly used for rolling pass design.

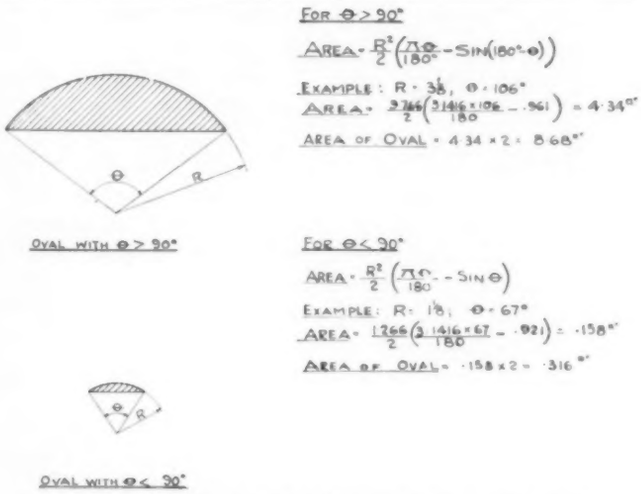

FOR Θ > 90°
AREA = R²/2 (πΘ/180 - SIN(180°-Θ))
EXAMPLE: R = 3½, Θ = 106°
AREA = 3.766/2 (3.1416 x 106/180 - .961) = 4.34"
AREA OF OVAL = 4.34 x 2 = 8.68"
OVAL WITH Θ > 90°
FOR Θ < 90°
AREA = R²/2 (πΘ/180 - SIN Θ)
EXAMPLE: R = 1⅜, Θ = 67°
AREA = 1.266/2 (3.1416 x 67/180 - .921) = .158"
AREA OF OVAL = .158 x 2 = .316"
OVAL WITH Θ < 90°

Figure 42 — Sketch gives formula for area of oval.

TABLE III

Basic Formulas for Weights and Areas of Steel Bars

Weight per foot — Rounds =	D^2 x 2.67
Weight per foot — Squares =	D^2 x 3.40
Weight per foot — Hexagon =	D^2 x 2.94
Weight per foot — Octagon =	D^2 x 2.82

Weight per Foot of Any Section ÷ 3.40 = Area

Area of Rounds =	D^2 x 0.7854
Area of Squares =	D^2
Area of Hexagon =	D^2 x 0.866
Area of Octagon =	D^2 x 0.8284

TABLE IV

Nominal Dimensions of Hot Rolled Hexagons and Octagons

Size, in.	Nominal rolled diam, in.	Hexagon: Side = D x 0.57735, Long diam = D x 1.1547		Octagon: Side = D x 0.4142, Long diam = D x 1.0824	
		Side, in.	Long diam, in.	Side, in.	Long diam, in.
1/4	0.250	0.144	0.289	0.1035	0.271
5/16	0.313	0.180	0.360	0.1292	0.338
3/8	0.375	0.216	0.433	0.1553	0.406
7/16	0.438	0.252	0.505	0.1810	0.473
1/2	0.500	0.288	0.577	0.2071	0.541
9/16	0.563	0.324	0.649	0.2327	0.608
5/8	0.625	0.361	0.722	0.2588	0.676
11/16	0.688	0.396	0.793	0.2845	0.744
3/4	0.750	0.433	0.866	0.3106	0.812
13/16	0.813	0.468	0.938	0.3363	0.879
7/8	0.875	0.505	1.010	0.3624	0.947
15/16	0.938	0.541	1.082	0.3881	1.014
1	1.000	0.577	1.155	0.4142	1.082
1 1/16	1.063	0.613	1.226	.....	.....
1 1/8	1.125	0.648	1.299	0.4659	1.218
1 3/16	1.188	0.685	1.371	.....	.....
1 1/4	1.250	0.721	1.443	0.5177	1.353
1 5/16	1.313	0.757	1.515	.....	.....
1 3/8	1.375	0.793	1.588	0.5695	1.488
1 7/16	1.438	0.829	1.659	.....	.....
1 1/2	1.500	0.865	1.732	0.6213	1.624
1 9/16	1.563	0.902	1.804	.....	.....
1 5/8	1.625	0.938	1.876	.....	.....
1 11/16	1.688	0.974	1.948	.....	.....
1 3/4	1.750	1.010	2.021	0.7248	1.894
1 13/16	1.813	1.046	2.092	.....	.....
1 7/8	1.875	1.082	2.165	.....	.....
1 15/16	1.938	1.118	2.237	.....	.....
2	2.000	1.154	2.309	0.8284	2.165
2 1/16	2.078	1.200	.....	.....	.....
2 1/8	2.141	1.236	.....	.....	.....
2 3/16	2.203	1.272	.....	.....	.....
2 1/4	2.266	1.308	2.616	0.938	2.453
2 5/16	2.328	1.344	.....	.....	.....
2 3/8	2.391	1.380	.....	.....	.....
2 7/16	2.453	1.416	.....	.....	.....
2 1/2	2.516	1.453	2.905	1.042	2.723
2 5/8	2.648	1.529	.....	.....	.....
2 3/4	2.773	1.601	3.202	1.148	3.001
2 7/8	2.898	1.673	.....	.....	.....
3	3.023	1.745	3.491	1.252	3.272
3 1/8	3.148	1.817	.....	.....	.....
3 1/4	3.273	1.890	3.779	1.356	3.543
3 3/8	3.398	1.962	.....	.....	.....
3 1/2	3.523	2.034	4.068	1.459	3.678
3 5/8	3.656	2.110	.....	.....	.....
3 3/4	3.781	2.183	4.366	1.566	4.092
3 7/8	3.906	2.255	.....	.....	.....
4	4.031	2.327	4.654	1.669	4.363
4 1/4	4.281	2.472	4.943	1.773	4.634
4 1/2	4.531	2.616	5.232	1.877	4.904
4 3/4	4.789	2.765	5.530	1.984	5.184
5	5.039	2.909	5.818	2.087	5.454
5 1/4	5.289	3.054	6.107	2.191	5.725
5 1/2	5.538	3.197	6.395	2.294	5.994
5 3/4	5.812	3.355	6.711	2.407	6.291
6	6.062	3.500	7.000	2.511	6.561

TABLE V

Round Plug Sizes

Diam, in.	Plus size, in.	Diam, in.	Plug size, in.
7/32	0.221	1 13/16	1.834
15/64	0.237	1 27/32	1.866
1/4	0.253	1 7/8	1.897
17/64	0.269	1 29/32	1.929
9/32	0.285	1 15/16	1.951
19/64	0.300	1 31/32	1.982
5/16	0.316	2	2.024
21/64	0.332	2 1/16	2.103
11/32	0.348	2 1/8	2.166
23/64	0.364	2 3/16	2.229
3/8	0.379	2 1/4	2.292
25/64	0.395	2 5/16	2.356
13/32	0.411	2 3/8	2.418
27/64	0.427	2 7/16	2.482
7/16	0.443	2 1/2	2.545
29/64	0.458	2 9/16	2.616
15/32	0.474	2 5/8	2.680
31/64	0.490	2 11/16	2.742
1/2	0.506	2 3/4	2.806
17/32	0.537	2 13/16	2.869
9/16	0.569	2 7/8	2.933
19/32	0.601	2 15/16	2.995
5/8	0.632	3	3.059
21/32	0.664	3 1/16	3.122
11/16	0.696	3 1/8	3.186
23/32	0.727	3 3/16	3.248
3/4	0.759	3 1/4	3.312
25/32	0.791	3 5/16	3.375
13/16	0.822	3 3/8	3.439
27/32	0.854	3 7/16	3.502
7/8	0.885	3 1/2	3.565
29/32	0.917	3 5/8	3.700
15/16	0.949	3 3/4	3.826
31/32	0.980	3 7/8	3.953
1	1.012	4	4.079
1 1/32	1.044	4 1/8	4.206
1 1/16	1.075	4 1/4	4.332
1 3/32	1.107	4 3/8	4.459
1 1/8	1.138	4 1/2	4.585
1 5/32	1.170	4 5/8	4.720
1 3/16	1.202	4 3/4	4.846
1 7/32	1.233	4 7/8	4.973
1 1/4	1.265	5	5.100
1 9/32	1.297	5 1/8	5.226
1 5/16	1.328	5 1/4	5.352
1 11/32	1.360	5 3/8	5.479
1 3/8	1.391	5 1/2	5.605
1 13/32	1.423	5 5/8	5.755
1 7/16	1.455	5 3/4	5.882
1 15/32	1.487	5 7/8	6.008
1 1/2	1.518	6	6.135
1 17/32	1.550	6 1/4	6.388
1 9/16	1.581	6 1/2	6.641
1 19/32	1.613	6 3/4	6.910
1 5/8	1.644	7	7.163
1 21/32	1.676	7 1/4	7.416
1 11/16	1.707	7 1/2	7.669
1 23/32	1.739	7 3/4	7.922
1 3/4	1.771	8	8.175
1 25/32	1.802		

Diam x 1.012 = Plug size.

Note: Plug sizes for Rounds over 2-in. diam are based on size plus one-half of AISI tolerance.

shown in terms of depth. A ratio of 0.014 per in. (finished size) is normally used.

As the size increases, the effects of spreading change and one comes to a stage where spread reverses itself and a combination of concave and convex becomes necessary keeping the depth constant, as shown in Figure 39.

There are a number of additional formulas which have not been covered. They include solution of triangles, segments of circles, weights of standard sections, plug sizes for rounds, etc., all of which are a part of basic roll design and rolling. They are included in Tables II through V of this paper.

DISCUSSION

PRESENTED BY

LEWIS W. KING, Assistant to Vice President-Engineering, Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

A. M. CAMERON, Superintendent, Blooming and Bar Mills, Atlas Steels, Ltd., Welland, Ontario, Canada.

ALBERT H. HIGHLEY, Assistant Superintendent-Hot Rolls, Carpenter Steel Co., Reading, Pa.

Lewis W. King: The author said, in the rolling of alloy ingots, in the early stages, it is necessary to roll at reduced speed due to the size of the ingot and the relatively small diameter of the rolls. I would like him to elaborate if he has had any experience with the rolling of ingots to blooms of high alloys at reduced rolling speeds? That is speeds that are much slower than conventional speeds required to obtain a given amount of tonnage in a given length of time. What effect does the rolling at lower speeds have on the internal structure of the bloom?

A. M. Cameron: In answer to your question, when our 26-in. blooming mill was designed, we knew that the arc of contact on a small mill might have some effect on the internal structure of the finished billet or bloom. When we first started the mill, we had difficulty making a good sound center on 6 x 6 in. from a 20-in. ingot. This occurred on a grade containing over one per cent carbon, one per cent magnesium and one per cent tungsten.

However, on this same grade and by reducing the speed of rolling during the early stages of reduction, we were able to produce 9 x 7 in. or 8 in. square of good quality and sound center.

Albert Highley: When you are rolling the higher alloys like stainless type 309 and 310, do you use the conventional method of rolling?

A. M. Cameron: Stainless 309 and 310 can be rolled, using the conventional methods of rolling that I have shown, however, you generally find that you will have to start with a smaller billet than you would normally use when rolling 302 or 304. When the quantity warrants, a special roll design is most desirable, one which will reduce a larger billet and avoid forming sharp corners such as oval and round or oval and square reduction.

By S. O. EVANS
Manager of Tubing Operations
Babcock and Wilcox Co.
Beaver Falls, Pa.

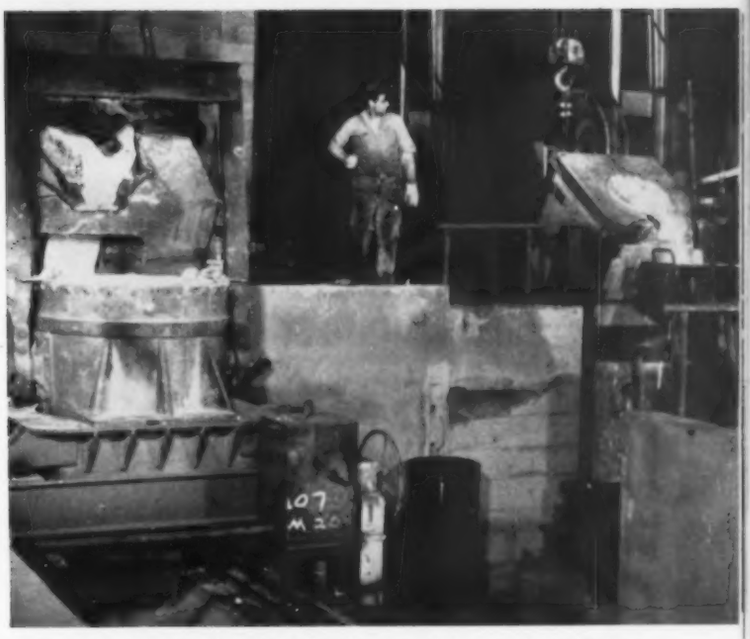


Figure 1 — The 1000-lb induction melting unit is being tapped.

INDUCTION HEATING IN TUBEMAKING

Application of induction heat must usually be based on some special advantages of the process to compensate for the higher cost per unit of energy which is normally required . . . . some of the possible advantages are scalefree heating, flexibility, ease of shutdown, ability to handle small heats of steel, and ability to heat with marked difference in temperature zones . . . .

▲ INDUCTION heating is a very versatile tool which can perform a wide variety of functions in tubemaking. The variety will include melting steel, heating billets, heating tube ends, tube welding, and even the stirring of molten steel for slag control, or for thorough mixing of the melt. This paper will cover only the three installations which are presently used in the production of tubes at the Beaver Falls plant of the Babcock and Wilcox Co. These are induction melting, induction heating of tube ends for upsetting, and induction reheating of billets for extrusion. The melting and tube-end heating will be described only briefly because they are installations of a type more or less common in steelmaking and fabricating. Reheating billets for extrusion will be covered more completely because the installation is of a type less familiar to steel fabricators.

INDUCTION MELTING

The induction melting unit, consisting of a 1000-lb and a 5000-lb furnace was added to steelmelting facilities consisting of four arc furnaces ranging in size from 25 to 60-ton capacity. While the added induction melting equipment was negligible in terms of total capacity, it made a major contribution to the over-all flexibility. Previously, 20 to 25 tons was the minimum size of melt, so that a quantity smaller than 20 tons of a non-recurrent item was impractical because the excess would either be dead stock or scrap. The induction equipment made 5000-lb or even 1000-lb heats available.

In addition to improving the productive flexibility of the steel mill, the induction melting equipment has

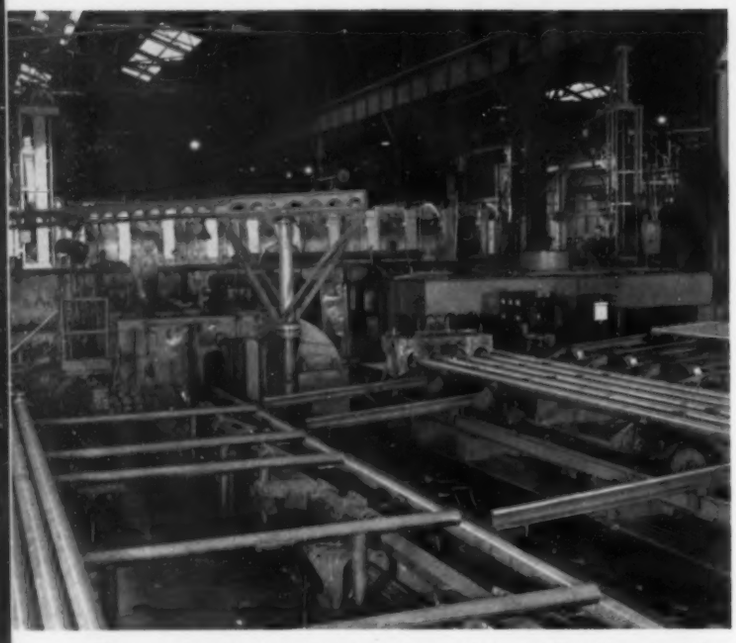


Figure 2 — Induction heating coil is in heating position for upsetting.

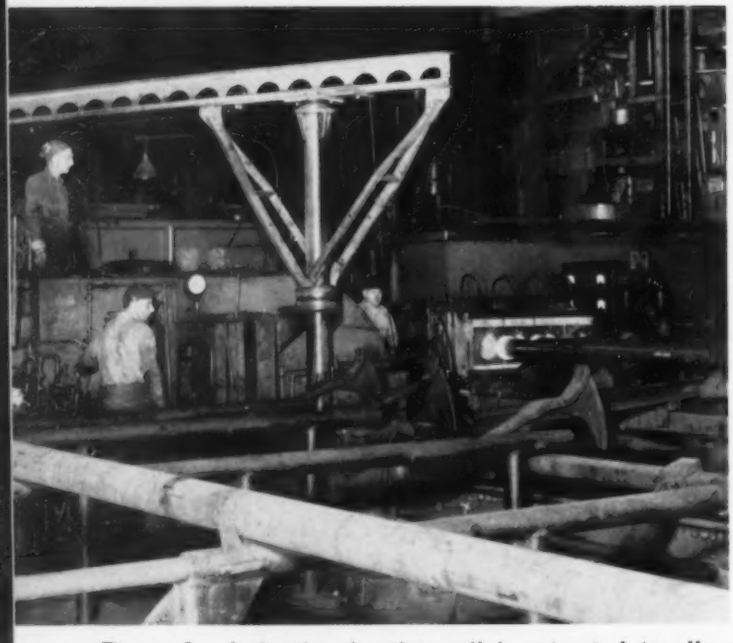


Figure 3 — Induction heating coil is retracted to allow tube advance.

proved of great value in research and development. A program of alloy investigation in which both the induction melting equipment and the extrusion facilities played a part, resulted in trials on over 50 materials with seamless tubing successfully produced in more than 40 analyses. Over half of these materials were not previously available as seamless tubing. The importance to this work of having small heats of metal available is obvious, because most of the alloys investigated are relatively expensive and the cost of such a program would be prohibitive if metal were available only in 20-ton heats.

Figure 1 shows the induction melting installation with the 5000-lb unit with its ladle and ladle buggy on the left and the 1000-lb unit in process of being tapped on the right.

The 1000-lb unit is tapped through a tundish into small billet-sized molds. The tundish is movable and is provided with a stopper so that it serves the dual purpose of slag separation and of transferring from mold to mold. In this way, the furnace can be tapped in one place continuously while the stream into the molds can be interrupted and moved. The molds are designed to provide sufficient metal to make extrusion billets after machining to remove the surface.

The 5000-lb furnace is tapped into a bottom pour ladle which is shown directly in front of it. The ladle is mounted on a ladle-buggy which travels over a pouring pit. The heat is teemed either into the small billet-sized molds used with the 1000-lb furnace or into a 19½-in. sq ingot mold.

From the standpoint of design, a 750-kw, 800-volt, 960-cycle motor-generator set feeds one or the other of these furnaces. The 1000-lb furnace is fed through an auto-transformer which provides stepped up voltage to the furnace and capacitor bank in parallel. The 5000-lb furnace is fed directly, with the 800-volt power fed into a tap part way down the winding so that the furnace itself acts as an auto-transformer with the full winding providing the rated voltage of the capacitor bank.

INDUCTION HEATING FOR UPSETTING

The values of induction heating for upsetting result from the sharp line of demarcation between hot and cold zones providing strength in the tube wall for the grips of the upsetter, from the high rate of heat input minimizing scaling time during heating, and from the low standby cost during off shifts.

Figures 2 and 3 show this unit in operation. A car carries the coils, advancing (Figure 2) to heat the tubes and then retracting (Figure 3) to allow the tubes to move one step forward. Thus each tube is heated successively in each of the four coils and then kicked out to roll down to the upsetter.

Five sets of coils are available, each built into a coil box as shown here. These sets provide a heating range from 1¼-in. outside diam tubing to 7½-in. outside diam tubing. Changing sizes involves only a matter of minutes since the electrical connection between car and box is by means of matching sets of bus bars on the top of the car and on the bottom of the coil box with the weight of the box and coils providing contact pressure. A change, then, requires only disconnecting two cooling water hoses, lifting off one box and replacing it with the new size, and reconnecting the cooling hoses.

The use of four coils is a design feature of particular importance in the heating of tubing. The purpose of this arrangement is to allow each tube a heating time of four cycles of upsetter operation to reach the desired temperature. Extended heating time is of greater importance in tubular than in solid heating, because of the non-uniform heating which results from any eccentricity which may be present. Since the same induced current must flow all the way around the tube, more than average power will be produced in the light wall because of its high resistance. The tendency toward non-uniform temperature which results from this

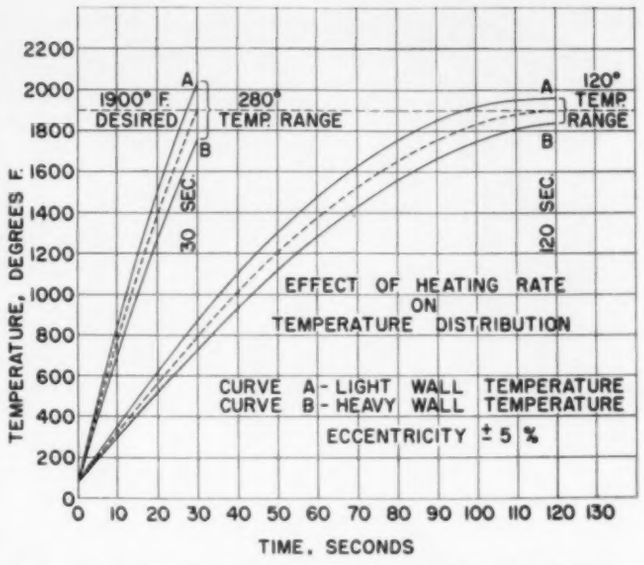


Figure 4 — Heating curves for 1-cycle and 4-cycle heating time show reduction in temperature variation with increased time.

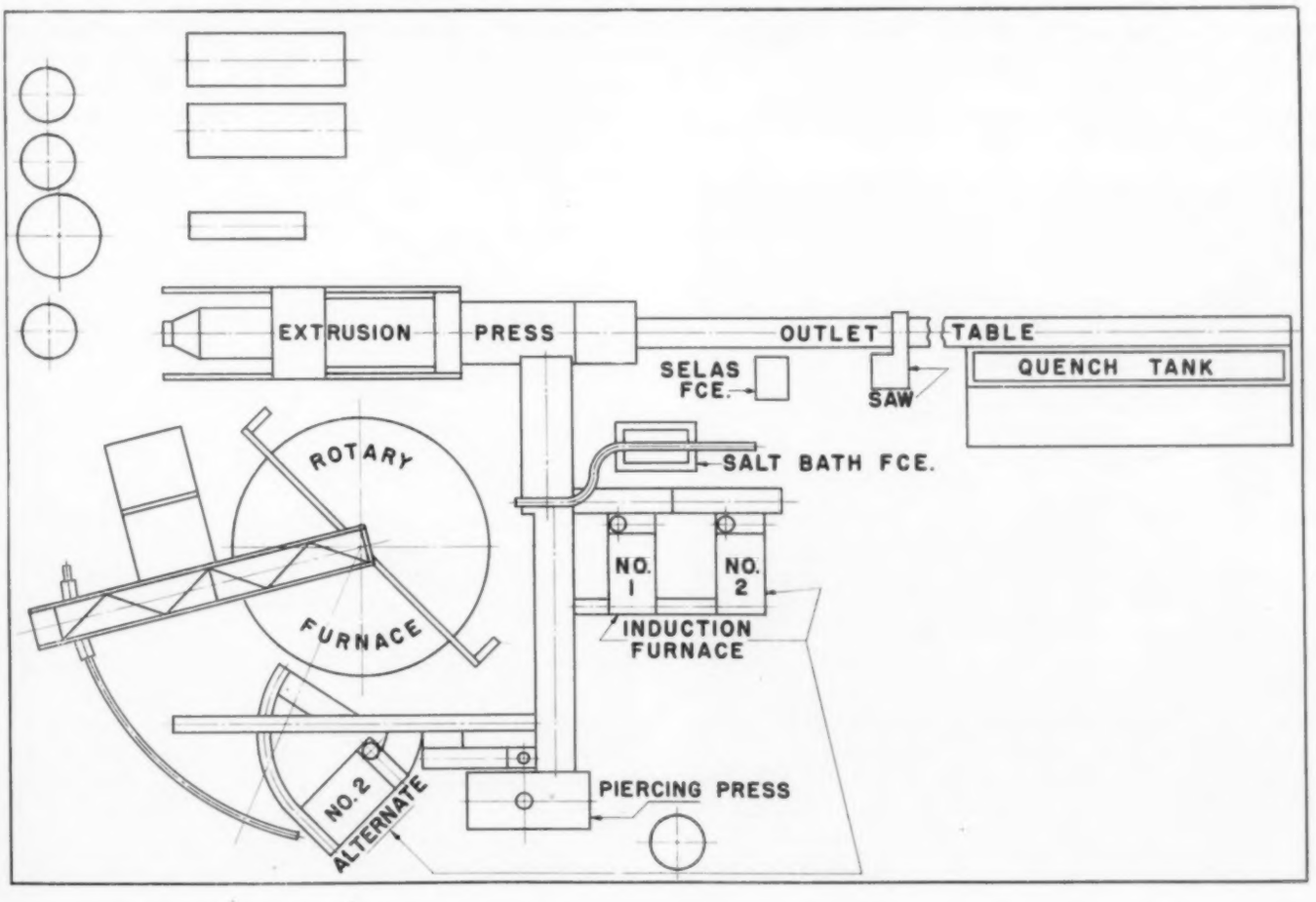
power discrepancy will be further aggravated by the fact that there is less-than-normal material on the light side so that it will heat faster-than-normal for any given power input. Conversely, both the lower resistance and the excess material to be heated in the heavy wall will tend to make its temperature below normal. Extending the time of heating by going to more coils minimizes the temperature variations by reducing the power input to the point where the radiation loss at the upsetting temperature almost equals input. Since radiation varies as the fourth power of temperature, only a relatively small per cent temperature variation will result from a relatively large per cent power variation under these conditions. A comparison of high and low speed heating for a tube having wall eccentricity of plus or minus 5 per cent of normal is shown in Figure 4. By increasing the heating time from 30 to 120 seconds the temperature variation from light to heavy wall is reduced from 280 to 120 degrees. This calculation is based on only the effects of power input and radiation. If the effect of heat conduction around the tube were included, the increase in time would be even more beneficial.

The power supply for this unit is a 750-kw, 400-volt, 960-cycle motor-generator set. Capacitors as well as the coils are carried in the reciprocating car so that only unity power factor current need be brought through the flexible leads which serve it. The temperature is controlled by voltage regulation of the supply and timing of the heating cycle. One timing and control system takes care of the heating cycle, retracting the car, feeding tubes into and through the system, positioning tubes for proper heating, and advancing the car for the following heating cycle.

INDUCTION BILLET HEATING FOR EXTRUSION

The reheating of billets for extrusion is a portion of an operating procedure and it is necessary to under-

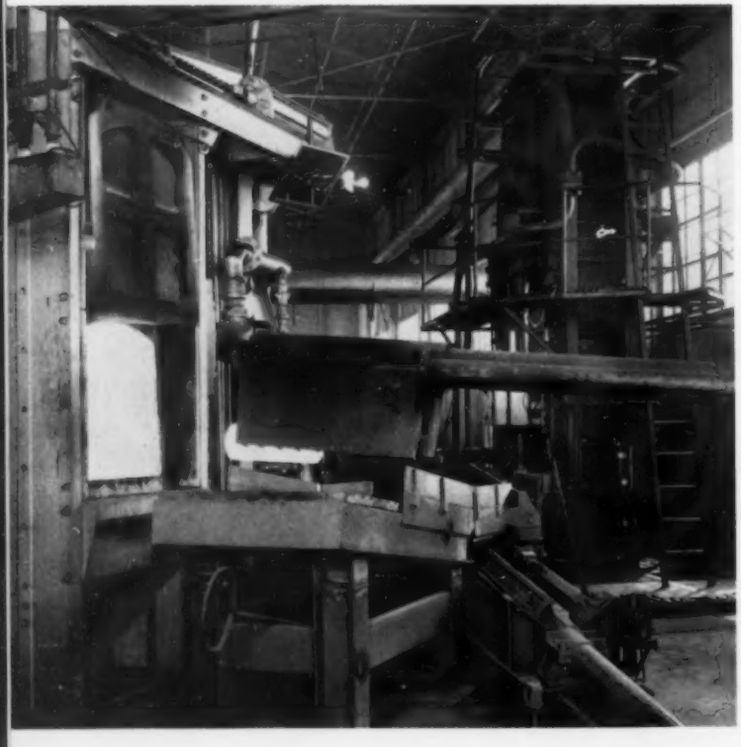
Figure 5 — Extrusion plant layout shows dual positions for second induction furnace.



stand the whole procedure to fully appreciate the function played by this one unit. At the present time, the major portion of the product of the extrusion department is austenitic stainless steel tubing. Any scale on the billet, as it enters the extrusion press, results in destructive scoring of the dies. Consequently, the function of the equipment ahead of the extrusion press is to provide an essentially scale-free hollow billet to the press for extrusion.

A layout of the plant is shown on Figure 5. The billets are heated in a rotary hearth furnace and transferred to a vertical 500-ton press where they are pierced by pressing a mandrel down through the center. They are then reheated in the induction heater and extruded. Prior to heating for piercing, the billet is coated with a protective frit which provides an enamel type coating and prevents scaling up to 2290 F, the temperature for piercing. This billet is shown in Figure 6 as it comes from the furnace. During the transportation and piercing of this billet, several hundred degrees of temperature are lost. Figure 7 shows this billet as it comes from the piercing press. At this point, it is necessary to reheat the billet for extrusion by a process which will either protect it from atmospheric oxidation or will heat it fast enough that a destructive scale is not formed. This prevention of scaling is necessary because the inside surface is freshly pierced and consequently has no protective coating, and the outside surface coating has been damaged during the mechanical process of piercing. It is at this point that the induction heater comes into play, reheating the billet from 0.6 to 2.0 minutes, a time which is sufficiently short that no appreciable scale is formed. Figure 8 shows this induction heater with the hot billet being discharged to the conveyor which carries it over to the extrusion press and the cool billet waiting to enter the coil.

Figure 6 — Billet after heating in rotary hearth furnace is ready for piercing.



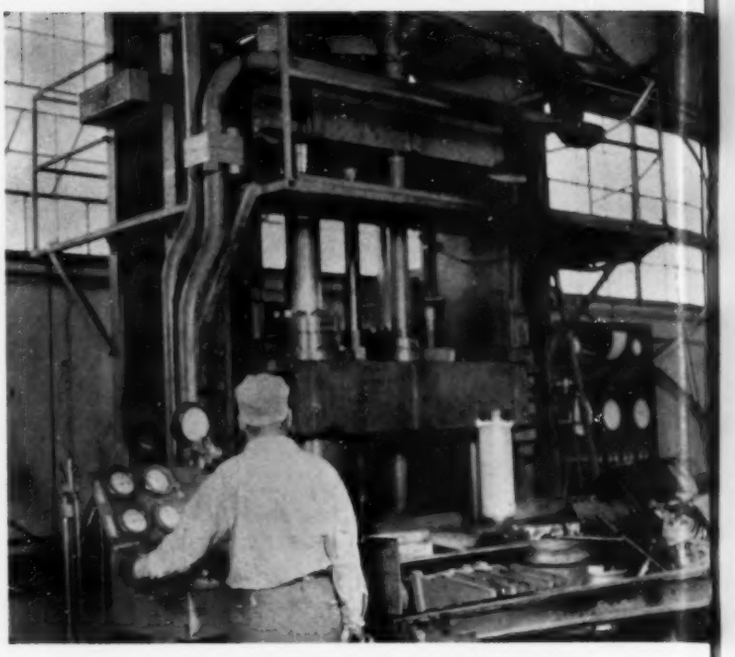


Figure 7 — Billet is pierced in a vertical press.

The most significant aspects of this induction heating installation relate to the quality of the resulting extruded product. First, extrusion of tubing requires uniform heating around the axis, because a cold and a hot side would cause a discrepancy in the flow of the steel resulting in eccentricity of the tube. The uniformity produced by induction is highly satisfactory. Second, the heating method should either protect the billet from air or be fast enough that die-destroying scale does not get a chance to form. Induction heating adapts very well to the provision of inert atmosphere. This equipment is capable of being run with such an atmosphere, but it has been unnecessary to provide it on the major portion of the work because the small reheating time, about 1½ minutes, does not cause a significant scale on the stainless being processed. Third, the means of heating should be such in terms of time and corrosive conditions that the extruded surfaces will be good. The induction reheat has given superior outside and inside surfaces. Fortunately, the inside surface which would be most difficult to repair by grinding is particularly good.

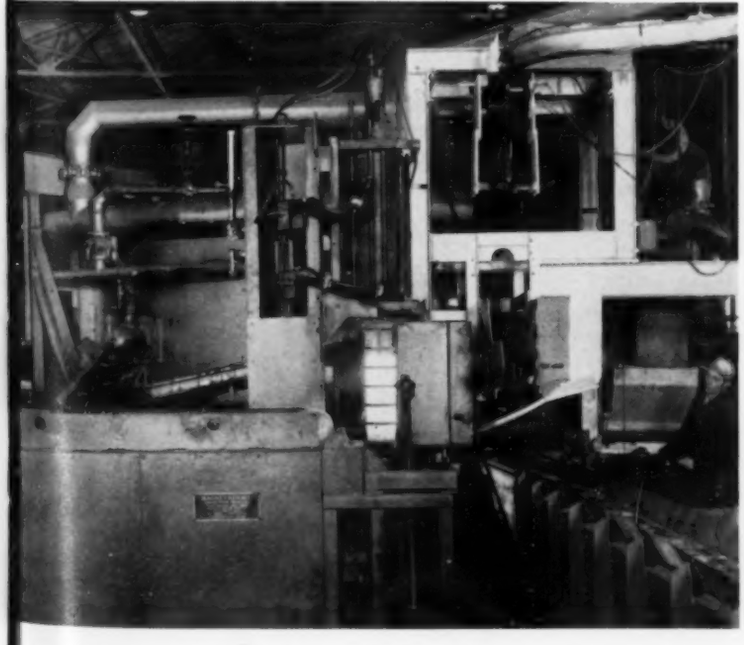
From the standpoint of operations, the unit is highly satisfactory. Overall power costs are low because there is no standby loss. Except for control and billet handling equipment, there is no power consumed except during the actual heating cycle. Maintenance and lost time are at a minimum. The billet handling equipment is simple and trouble free. Early troubles in finding liners capable of standing 2300 F have been resolved so that maintenance cost for the coil unit is low. Another operational feature of importance is the small number of billets being heated at any one time which is a secondary benefit resulting from low heating time. This means that any delay elsewhere in the production line results in only a minor problem in storage and scaling of billets.

At the present time of paper presentation, April 1955, one unit is in operation. In order to be in complete bal-

ance with the remainder of the productive equipment, however, a second unit has been obtained and is in process of installation. With the addition of this second unit, much greater flexibility of the overall plant will be achieved by virtue of considering this unit as semi-portable and making it available to expand the range of alloys producible in the plant. In Figure 5, the floor arrangement shows the two alternative positions of the second unit. In the one case, it will merely augment the capacity of the first unit allowing an increase in production. In a second location between the rotary hearth furnace and the piercing press, it will make possible the production of materials which cannot be heated all the way up to piercing temperatures with only a frit protection. Consequently, these materials will be preheated in the rotary furnace with or without a frit protection to some temperature at which scaling is not prohibitive, after which they will be transferred to the induction unit, heated quickly from that temperature to the piercing temperature, pierced, reheated, and extruded. This will greatly facilitate the production of the lower alloy steels which can be produced only very slowly with the equipment presently at hand.

The induction equipment is a 400-kw, 60-cycle, single-phase unit fed directly from a 2300-volt line. An outdoor cubicle houses capacitors for power factor correction. Coils are available for handling 7.1-in. maximum and 8.2-in. maximum diameter billets up to 28 in. long. The heating rate is controlled by taps on the input transformer. Final billet temperature is controlled automatically by means of a radiation pyrometer, which controls the main breaker and shuts off power when the set temperature is reached. If the control remains on and the temperature drops after the initial heating cycle, the power will come back on automatically to bring the temperature back up, cycling in this manner until the control is shut off and the billet is withdrawn. Hydraulic manipulating equipment brings the billet into the charging trough, up-ends it and lifts it into the coil for heating. After the billet is heated, the same equipment lowers it and kicks it out to the conveyor for delivery to the extrusion press.

Figure 8 — Induction heater with heated billet is being discharged and a pierced billet is on the charge bed.



SUMMARY

Induction heating provides a very adaptable tool which performs widely divergent functions in the production of tubes. In general, the application of induction heat must be justified on the basis of some special attribute of the equipment in order to compensate for the higher cost per unit of energy that is normal with this type of equipment. Some of the attributes which may be of importance are the ability to make small heats of steel, the ability to heat with sharp differentials in temperature zones, the ability to provide relatively scale-free heating either as a result of high speed heating or as a result of using a unit which is relatively easy to charge with a special atmosphere, the elimination of standby losses, and the flexibility of a semi-portable heating means.

DISCUSSION

PRESENTED BY

LLOYD B. SHEETZ, Fuel Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

R. T. WINTERRINGER, Assistant Superintendent Electrical Department, Republic Steel Corp., Chicago, Ill.

S. O. EVANS, Manager Tubing Operations, Babcock and Wilcox Co., Beaver Falls, Pa.

Lloyd B. Sheetz: We have been experimenting with the heating billets for extrusion for the last year by 60-cycle and also 600-cycle induction furnaces.

As Mr. Evans stressed, uniform heating is an absolute necessity. It is especially true when you are extruding a shape. We ran something like 40 or 50 experimental heatings with thermocouples located in various positions in the billet. Temperature differences were found which were quite substantial and we viewed this with some apprehension.

However, we also put thermocouples in similar positions and placed the billets in our 900 and 1400-kw salt bath furnaces. We found about the same temperature differences in the salt bath heated billet as in the induction heated billet.

However, when you heat from room temperature, as in our setup, to extrusion temperature in one heating without any piercing operation, it becomes necessary to protect the surface from scaling. So what we have in mind now and what we anticipate doing is to use the induction heater as a pre-heater, followed by a small salt bath furnace to clean up the surface.

R. T. Winterringer: On heating for upset, do you use any kind of a refractory cylinder in the coils to protect the coil?

S. O. Evans: On our induction heater for upsetting, we use a castable refractory which we trowel into the inside of the coil. We have always used a castable as against a pre-molded cylinder refractory for these coils.

Two first-class slabbing blooming mills are now available at Sparrows Point as a result of a modernization program which cost a fraction of what one complete new mill would have cost . . . . performance has met all expectations.

Figure 1 — Close-up of the old 46-in. mill in operation, from the front off-drive side.

Modernization of Blooming and Slabbing Mills

Engineering and Mechanical Features

By P. E. APPEL
Project Engineer
Engineering Department
and
M. WHITMORE
Assistant Master Mechanic
Rolling Mills
Bethlehem Steel Co.
Sparrows Point, Md.

▲ THE intent of this paper is to briefly cover recent improvements to the slabbing-blooming mills at Bethlehem Steel Co.'s Sparrows Point plant, with emphasis on the mechanical aspects of the engineering, construction and actual equipment installation.

In June 1952, construction orders were issued for improvements which entailed conversion of the 46-in. blooming mill to a 54-in. high lift slabbing-blooming mill and modernization of the 40-in. blooming mill.

The conversion to a 54-in. mill was, of course, a more involved job and represented a substantially greater expenditure than did improvements to the 40-in. mill. The first and greater part of the paper is therefore devoted to this project.

The purpose of converting from a 46 to a 54-in. mill was to provide additional primary reduction capacity. This was to be done by making possible the use of larger ingots, and the rolling of larger product sections, under improved control and speed conditions.

The 46-in. mill, installed in 1926, handled ingots up to 50 in. wide, and produced strip and plate slabs up to 46 in. wide. To realize the desired capacity, it was decided that the new mill should handle ingots up to 66 in. on edge, and produce strip and plate slabs up to 62 in. wide. This required an entirely new mill stand with longer and larger diameter rolls. The lift was set to provide a 66-in. working opening at the bullhead with maximum diameter rolls. The body length was set at 106 in. to provide a 69 in. wide bullhead, and an eight and a twelve in. pass.

The 14-in. increase in roll-body length was to be divided symmetrically about the center line of the mill, and the travel of the manipulator and sideguards was to be increased accordingly. Higher and heavier sideguards, and manipulator fingers with higher lift were to be installed on the entry side of the mill. As the wider mill would take seven inches off the length of the spindles it was decided that the existing spindles would be shortened and the top spindle angle, of ap-

proximately 10 degrees maximum, would be maintained. The pinions were to be increased to 54-in. pitch diam and the center line of the bottom pinion was to be raised 12 in., necessitating raising of the main mill motor by that amount. This meant that the bottom spindle would have a negative angle of about three degrees. To handle the wider ingots and slabs, it would be necessary to widen the shear chute and all approach and delivery table stationary sideguards.

This larger mill with high-speed worm-driven screwdown, individual motor-driven feed and housing rollers, and 54-in. pitch diam pinions, is now known as a 54 x 106-in. slabbing-blooming mill.

Following a complete engineering study of the detailed requirements, it was decided that in addition to the major changes mentioned above, we would shop recondition front and rear mill table girders, design and build new front and rear mill table drives to handle the increased table loads, install a scale-sluice system and heavy-plate chutes under the front and rear mill tables, and provide a new modern air-conditioned mill-operators pulpit complete with sanitary service facilities.

Soon after initial equipment orders were placed, a detailed parts and material list, covering the entire job, was prepared. Differentiation was made between new parts required, existing parts to be altered or reconditioned, and spare part requirements.

Figure 2 — The two new main tie beams and the front shoe plate for the 54-in. mill, have just been lowered into place over the foundation bolts. The chain falls and leveling cables, together with the main lifting cables, are suspended from the main block of the overhead mill crane. In the upper right is one of the two erection cranes handling parts for the scale-sluice system.

at Sparrows Point Plant

After engineering, design and manufacture of the equipment, it was inspected by Bethlehem representatives at the supplier's shops. On being delivered to Sparrows Point, the parts were checked and given a more complete inspection. Insofar as possible, subassemblies were built so that there would be a minimum of assembly work during mill downtime. Other parts were either assembled and torn down, or checked accurately for fit. All parts were completely match marked.

During the week previous to starting the job, all of the equipment normally stored in the mill building was removed to make room for new parts and special equipment for the installation. Heavy wooden bins were built for storage of small parts. Larger parts and subassemblies were systematically stored in one area. Another area was kept as clear as possible for landing parts from the old mill. Floor trench plates were reinforced at strategic locations, and two truck cranes moved into place for handling lighter lifts largely confined to the front and rear mill-table areas. The overhead mill crane was completely checked and put in first class operating condition. An open-front lean-to was built and equipped with a complete set of drawings, material lists, work schedules, etc.

For purposes of lining up forces and arranging crane service, the job was divided into four main sections: (1) mill section proper, (2) front mill-table section, (3) rear mill-table section, and (4) shear section. The job was planned so that the mill section would be serviced by the 60-ton overhead mill crane; the front table section, insofar as possible, by one of the two mobile truck cranes; the rear table section by the other mobile

Figure 3 — The new 54-in. mill is nearing completion. To the left is the new pinion housing assembly. On the front side of the mill is a new housing roller assembly being installed.

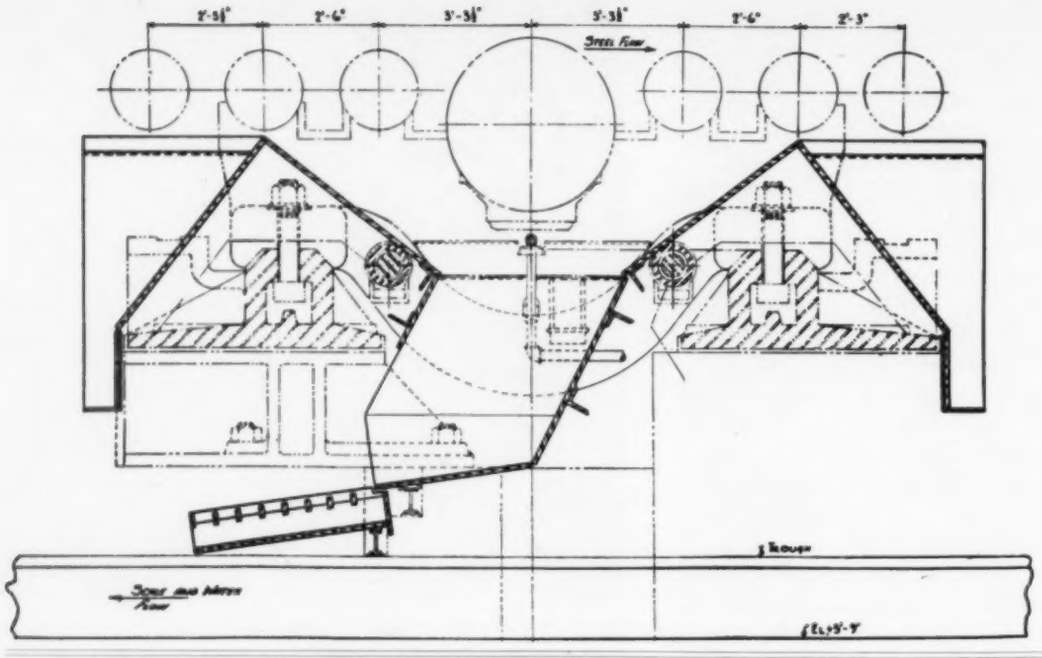


Figure 4 — Sectional elevation of the underside of the mill, facing the drive end. All the scale and butts falling between the two outside housing rollers funnel to the center of the mill and drop to a bottom plate. Scale and mill-roll cooling water moves downward to the left and falls through a heavy flatbar screen having 6½ in. square openings. It is then channeled into the straight through sluice trough beneath. Butts are removed from the top of the screen with a chain fall suspended from a monorail under the front mill table.

truck crane; and the shear section by a large portable floor winch for light work, and the overhead mill crane for heavy work. A master schedule was made to cover the entire job. Detailed work schedules were made for each section.

Forces were lined up to cover the job on a three-turn, seven day a week basis. Though requirements varied with the stage of the job, the average line-up per turn over the entire period was approximately 50 men, not including the mechanical manpower requirements of the electrical department for raising the main mill motor. Supervision on each turn was to consist of three millwright foremen, two erector leaders, one labor foreman and one rigger leader. It was decided that overall supervision could best be handled on a joint basis by the mill master mechanic and the construction foreman.

At 7 am on January 18, 1954, the mill was shut down and dismantling begun. During the first twenty-four hours, all front mill-table girders and the two rear table girders adjacent to the mill were removed. Also, the mill rolls, furniture, spindles, carrier bars and main

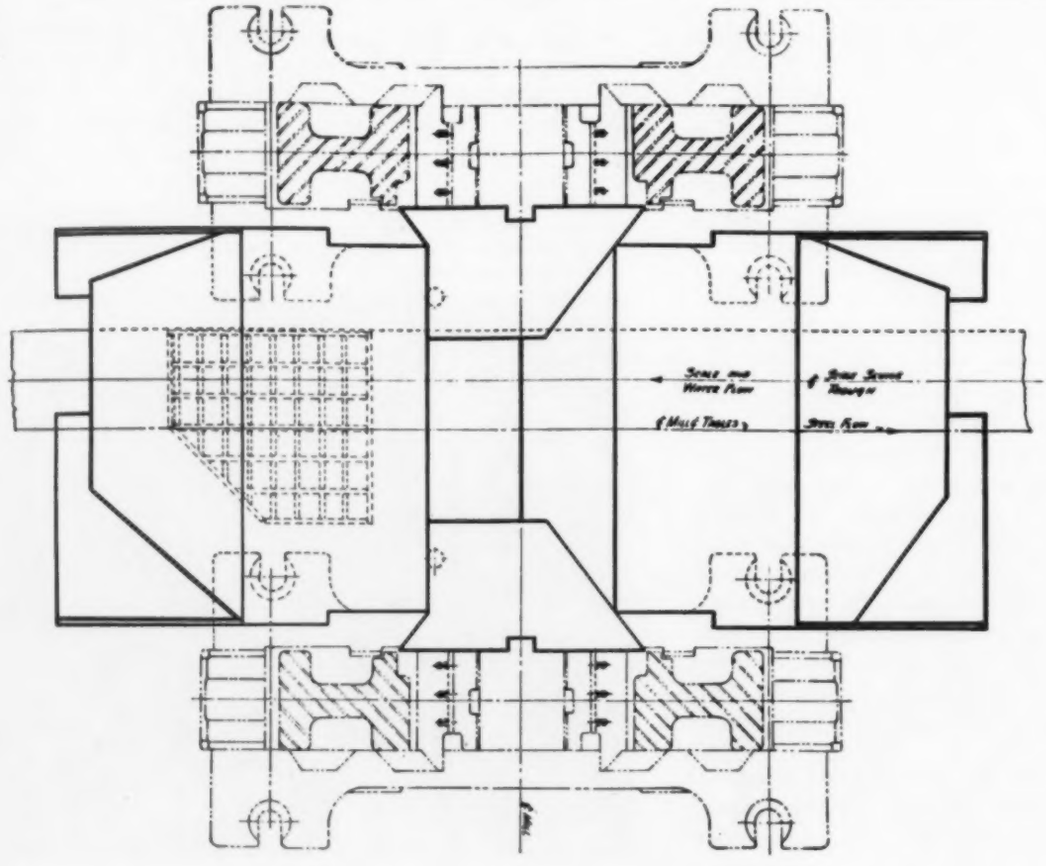


Figure 5 — Plan of the scale chutes at the underside of the mill. The method of channeling scale and water to one side for proper entry into the trough is shown.

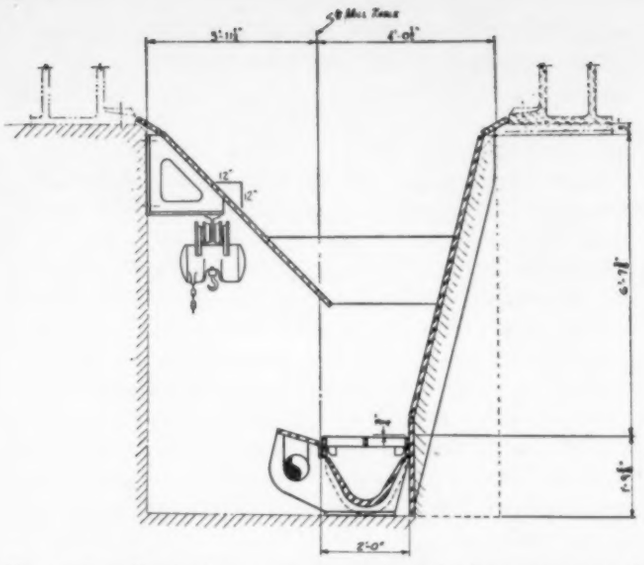


Figure 6 — Typical cross section through the main tunnel directly under the front and rear mill tables. The 1¼-in. scale deflector plates are welded to the bottom flanges of the table girders. A cross section of the sluice trough is shown at the bottom. The flanged trough castings are cradled in plate supporting brackets and the heavy flatbar grates are supported independently. A chain fall monorail for handling of butts is shown at the left.

coupling connecting parts were removed. On the second day, the mill housings, shoe plates and pinions were removed. The two main tie beams, which measured about twenty-eight feet long, four feet wide and five feet high, were for the most part embedded in concrete and were quite difficult to remove. It was necessary to cut down on all sides, and jack, in addition to pulling with 1½-in. cables from the overhead crane. To permit installation of the "straight through" sluice troughing, it was necessary to remove a large section of concrete at the center of the mill. The removal of the old tie beams, preparation of the foundation and pouring of concrete to rough grade for the new base castings were completed on the fourth day; 3,000-lb high early concrete, with a 2 per cent calcium chloride admixture, was used. As the job was done in cold weather, coke-fired bullies were strategically placed and the area covered with corrugated sheeting. This produced a dutch oven effect to prevent freezing and accelerate curing. A 2600-lb concrete was thereby obtained in about forty-eight hours.

On the fifth day, the main mill tie beams and shoe plates were placed, set and grouted. Previous to shutting down for the conversion, the two tie beams and two shoe plates were set up and checked for correct shoe plate gage. At that time, the front shoe plate was bolted and keyed to the two tie beams. The preassembly of these parts made the setting of the bottom castings considerably easier, in that the whole base for the mill was set as one unit. Also, it meant less crane time in handling, as there was only one lift to make instead of three. However, in having to enter simultaneously on thirty-six 4-in. foundation bolts spread over an area of more than 600 sq ft, we had to be sure that each bolt would meet the proper bolt hole. Before the start of the job, the bolt holes of the subassembly were accurately checked and charted for location and size. Upon comparing this information with the drawings, it was found that additional bolt clearance was desirable at several locations. This was provided. Also, lifting and leveling cables were placed in proper position on the tie beams-shoe plate assembly and tried and adjusted before starting the job. Just as soon as possible after removal of the old base castings, the foundation bolts to be used for the new castings assembly were carefully checked for location. It was necessary to heat and bend several bolts to proper position.

Previous to setting the main base castings, they were surrounded by coke-fired bullies for several days to take off the chill. Quick setting grout and a dutch

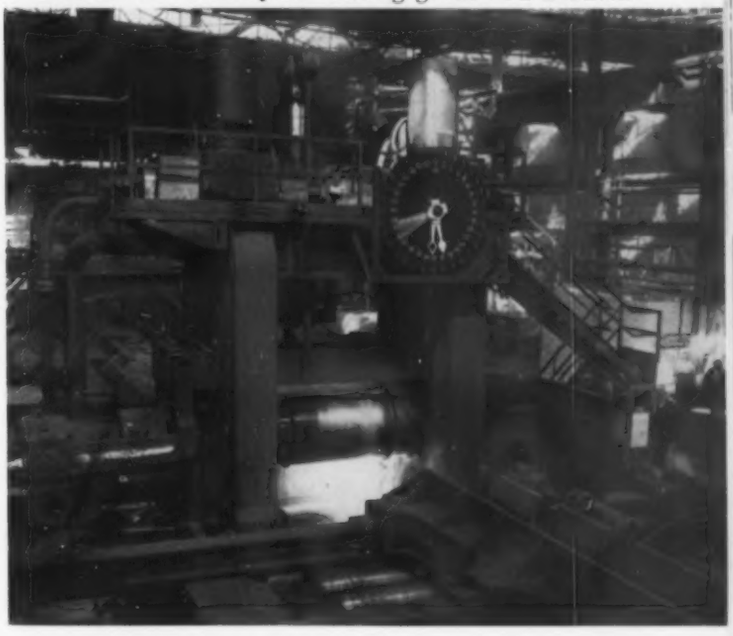


Figure 7 — Front drive side of the new 54-in. mill shows at the lower left, the bottom spindle pitching down to the mill. At the lower right are the new front sideguards and manipulator. In the background, to the right is a brick enclosed grease station in which are located the automatic systems for both the 40- and 54-in. mills.

Figure 8 — Close-up of the rear side of the old 40-in. mill.

Figure 9 — The new 40-in. mill housings are set up on the floor, being prepared for the pending job. The old 40-in. mill, still in operation, can be seen in the background. The new drive-side mill housing is shown fitted with a special lifting eye. Grease and water lines have already been mounted on the housings. In the lower center are the two screwdown motors with brakes and unjammers mounted on the top drive side casting. One of the top screwdown cover casting assemblies can be seen at the lower right.

oven effect accelerated curing. The grout cylinders checked at 3500 lb in twenty-eight hours.

Thirty-six hours after pouring grout, we began setting the main mill housings. This job was expedited in that before shutting down, we had very precisely scribed and punch marked on the shoe plates the exact location of the outside edges of the drive-side mill-housing feet. On setting the housing to this mark, the foot bolts were tightened and shrunk. The bottom separators and tie rods were placed and blocked up on the off-drive end. The off-drive mill housing was then placed, leaving about ½-in. opening between it and the bottom separators. After installing the mill-scale chutes, screws and nuts, top-roll bearings and carrier bars, the top mill separator casting was set and keyed in position. This top casting had previously been fitted complete with screwdown motors and top-roll balance cylinder and plunger.

The off-drive side housing was then jacked over tightly against the separators. All separators to housing bolts were tightened and shrunk, after which the off-drive side-housing foot bolts were tightened and shrunk. The handrailing for the top of the mill was then installed to provide maximum safety while assembling the remainder of the top. This work was completed on the morning of the eighth day.

The screwdown drive covers had previously been built up into drive and off-drive side assemblies. These two units were set and bolted in place on top of the mill. All of the remaining miscellaneous equipment was installed by the end of the twelfth day.

In addition to the mill proper being installed during this time, we also set and grouted a new pinion housing, new drives for the front and rear mill tables and reconditioned front and rear mill-table girders. Also we installed 1¼-in. plate scale-deflector chutes and piping and troughing for the scale-sluice system under the front and rear mill tables.

Digressing somewhat from the actual installation of equipment, it should be pointed out that the critical factor in the design of our scale-sluice system was the limited elevation differential between the mill tables and the tunnel floors beneath. Lowering of the floors would have been completely impractical in that they were already just slightly above the sewer level at normal high tides. We had to hold a certain minimum elevation differential between the mill tables and the top of the troughs in order to keep the scale sliding properly into the sluiceway. This left just enough head room to install the troughing with a fall of about 1/16-in. per foot.

Considerable experimenting had been done under similar conditions with the moving of various quantities of scale, using different pressures and different sizes and locations of nozzles. On the basis of the results, we had designed and installed a very satisfactory sluicing system for part of our 40 x 80-in. slabbing mill. We therefore had very definite ideas as to what would be required for the 54-in. mill.

The trough castings were made of a nickel-chrome iron possessing outstanding abrasion resistance, and having a Brinell hardness range of from 500 to 700. As they are very brittle, they must be protected from heavy impact. The troughs are made up in flanged sections over which are placed heavy flatbar grates to screen out butts and foreign matter. These grate sections are supported independently, so that the impact of heavy falling butts is not transferred to the castings. Nozzle spacing varies from five to about fourteen feet, depending on the amount and concentration of scale falling at various locations along the trough. Water

Figure 10 — The old 40-in. mill top assembly is being removed as one unit. To the left is one of the two erection cranes for handling lighter lifts in the front and rear mill table areas.

for the nozzles is picked up at the clean end of the scale pit by one of two 2000-gpm, 100-psi centrifugal pumps. In conjunction with the sluice system, a monorail system for handling butts was installed under the front and rear mill tables.

In addition to the jobs mentioned previously, all newly designed stationary sideguards and separators were installed on the roller tables from the ingot buggy track to the slab-loading buggy. At the 3000-ton steam-hydraulic shear, a new main cylinder was installed, a reconditioned small cylinder, a reconditioned knife block and a new wider shear chute. Five new automatic lubricating systems were installed at the mill. A grease system was provided for the front mill table, one for the rear mill table and a third for the mill rolls and chucks. Two oil systems were installed, one for the screwdown and another for the pinion sprays and bearings.

By the end of the twelfth day, all equipment was together and ready to try out. Most of the checking and getting the various units to function properly was completed on the thirteenth day. Trial ingots were rolled on the 7 to 3 turn and a full rolling schedule was resumed on the 3 to 11 turn of the fourteenth day.

In connection with improvements to the 40-in. mill, the original installation was made in 1918 and the maintenance of feed and housing rollers, housing seats, and the screwdown drive had become excessive. The mill stand assembly was also out of line and level because of foundation settlement, and the mill housing table girder seats had been badly beaten out. In order to take 43-in. wide ingots, it was also desired to widen the roll bullhead by 3 in. which would necessitate widening of the mill by that amount.

After a study of the requirements, it was decided that new mill shoe plates and mill housings, complete with worm-driven screwdown, and feed and housing rollers would be installed. In an effort to provide resilience and absorb shock, it was decided that to install a double steel spring grid-type flexible coupling between the main mill motor and pinions. This was to replace a slab-type lead spindle that had to be renewed about every eight weeks. It was agreed that all front and rear mill table girders would be shop reconditioned. New stationary sideguards and separators were to be provided at the approach to the front movable sideguards and at the runout of the rear movable sideguards, to line up with the three-in. wider mill. Also, it was decided that some minor changes to the sideguard drive would be necessary to permit additional movement to the off-drive side.

Shortly after the equipment orders were placed, check lists similar to those used for the 54-in. mill job were made to provide a means of proper parts control. The work preliminary to the actual installation was handled in much the same manner as has already been described in connection with the 54-in. mill. The line-up of forces for the job was also very similar.

On December 7, 1953, the mill was shut down and dismantling begun. The entire mill was dismantled, old shoe plates removed, concrete prepared and new shoe plates set and grouted by 3 pm of the second day. Twenty-four hours after completion of grouting, we began setting the mill housings. This was followed by

Figure 11 — The new 40-in. mill shoe plates are set and grouted. The new drive side mill housing is being lowered into position. In the background is the front side erection crane.

Figure 12 — The new 40-in. mill drive side housing is being set. The stripped pinion housing and the main mill motor can be seen in the background.

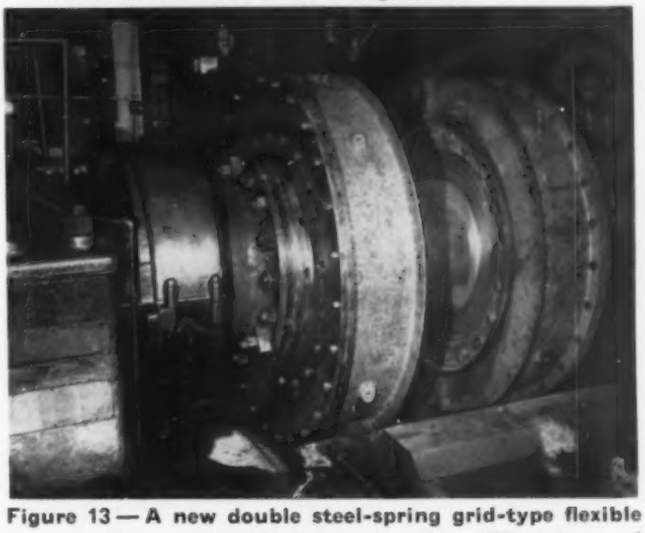


Figure 13 — A new double steel-spring grid-type flexible coupling was installed between the mill motor and pinions.

setting of the reconditioned table girders, which were grouted on the second turn of the fourth day. The table rollers, line shafts, manipulator parts and other miscellaneous equipment were installed by the morning of the sixth day. Mill rolls, spindles, etc., were installed

Figure 14 — The completed new 40-in. mill is shown from the front drive side.

and all equipment tried out on the sixth day. On the morning of the seventh day, trial ingots were reduced, and the regular rolling schedule was resumed on the second turn of the seventh day.

Other miscellaneous jobs done during the downtime, aside from the main mill job, included the installation of a new manipulator drive base and frame, a new manipulator finger yoke and frame, a main-drive double-spring grid-type flexible coupling, and new mill pinion housing liners and pinions. A new base for the roll balance accumulator was set and grouted. The cylinder was rebushed and a new plunger installed. The main posts and bottom knife block were replaced at the 500-ton upcut shear. Five new automatic lubrication systems were installed and put in service at the mill.

As a result of this modernization program, there are two first class slabbing-blooming mills at Sparrows Point, at a fraction of what one complete new mill installation would have cost. The performance of these two units has certainly met all expectations. The entire program, from its embryonic to completed stage was well planned and executed. This, of course, can be attributed to the exceptionally close teamwork of all parties involved. Of one thing we are particularly proud, and that is, not having had a dispensary case amounting to more than a nicked finger throughout the two installations.

DISCUSSION

PRESENTED BY

CHARLES E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

M. WHITMORE, Assistant Master Mechanic, Rolling Mills, Bethlehem Steel Co., Sparrows Point, Md.

Charles E. Pritchard: There was comment made in the paper covering the provision of a monorail crane for handling the removal of butts. I would like you to go into more detail as to your method of handling the butts from that point in the trenchway to the ultimate of depositing same in a scrap car.

Comment was made as to experimental work being conducted with the sluiceway system of the 40-in. mill prior to the actual conversion on both the 40-in. and 54-in. mills. What experience have you actually had since the installation of the redesigned sluiceway system as to water pressure, angle of spray and type of material comparisons with the experimental period.

M. Whitmore: The sluice trough under the mill and mill tables is covered by heavy fabricated flatbar grate sections having openings approximately six in. square. Butts fall on these grates and are removed by a manually operated chain fall suspended from a monorail. The monorail is suspended from the underside of the scale deflector chutes and "runs" the length of the tables. At the approach table end of the front mill table, we made an opening through the main table beam supporting wall and installed a submerged butt box pit to the outside. Butts from the monorail are dropped on a sloping plate, projecting into the tunnel under the front mill table, and slide into a butt box. Butt boxes are emptied into a scrap car by the ovehead mill crane.

As to the small-scale experimental work conducted prior to the installation of the sluice systems, we merely set up some crude troughs and varied the trough drop per foot, the size and position of nozzles and the water pressure. Mill scale was manually shoveled into the trough at various rates, and various locations in respect to the nozzles. After correlating the data obtained, we came to conclusions as to the water pressure and positioning and sizes of nozzles required to do our job. Subsequent operating results proved conclusively that our preliminary experimental findings were quite sound. It was considered impractical, however, to make trough material comparisons under any but actual operating conditions. After gaining some operating experience in this regard, we feel that the most economical material for the trough castings is a highly abrasive resistant nickel-iron casting having a hardness range of from 500 to 700 Brinell.

ELECTRICAL FEATURES

By H. W. DORSET

Assistant Superintendent

Electrical Department

Bethlehem Steel Co.

Sparrows Point, Md.

▲ CONCURRENT with the program for replacing the old mill stands, and rebuilding the mill tables on the 40 and 46-in. blooming mills, it was decided to improve the electrical equipment also. The drives for the Sparrows Point 40-in. blooming mill were put in service in 1919, the 46-in. mill in 1926, and the 40-in. slabbing mill in 1936. These mills had all operated under very heavy schedules for a greater part of the time since their installation, and had given a good account of themselves. However, it was realized that produc-

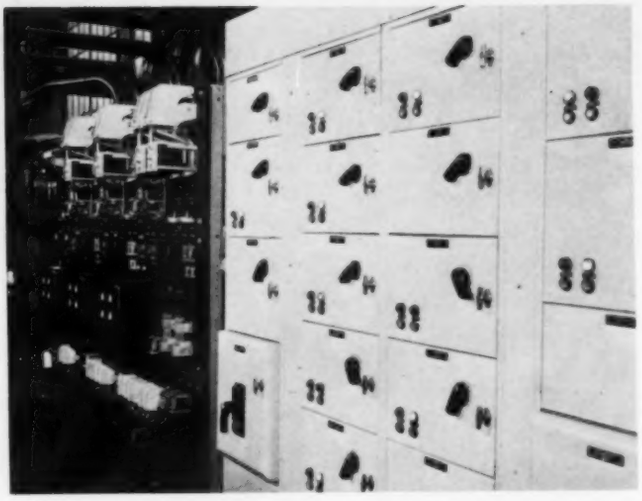


Figure 1 — Variable voltage control for the 40-in. mill screwdowns and sideguards and the 440-volt control center for both the 40-in. mill and the 54-in. mill, are in one location.

tion could be obtained by improving mill operation in several ways; first, by preventing the motor driving the 46-in. blooming mill from slowing down during long passes, and second, by making some of the auxiliaries, such as the mill tables, screwdowns, and sideguards faster, with quicker response. Since insufficient horse power in the 46-in. mill motor-generator set motor was responsible for the d-c drive slowing down, it was decided to replace it with a larger motor.

The outdoor substation, the unit substations, all of the variable voltage motor-generator sets, auxiliary motor-generator sets, and associated control were installed and wired prior to the actual shutdown of each mill. In those places where new control was to take the physical space occupied by existing control, the old panels, etc., were moved out on the motor room floor and wired temporarily to keep the mill in operation, thus leaving room for the permanent control.

The changes to the electrical equipment on the 40-in. blooming mill consisted of installing variable voltage drives on the screwdowns and sideguards, with rotating regulator excitation. New screwdown, shunt wound, frame 616, forced ventilated motors with brakes were installed. However, the existing sideguard drives, consisting of two, frame 90, and two, frame 80 motors, were simply changed from series to shunt wound. These motors were supplied with power from four 150-kw generators driven by a 750-hp motor, two generators for the screwdowns, and two for the sideguards. Each pair of sideguard motors is connected in series. See Figure 1.

The changes to the old 46-in. mill, hereafter called the 54-in. mill, were a little more extensive. New screwdown, frame 616, forced-ventilated, shunt-wound motors and brakes, four new feed rolls, frame 614, motors, and new spindle shifter motors, frame 606, compound-wound, were installed. The feed roll motors have 550-volt armatures and 230-volt shunt fields. The existing sideguard and table drives, all frame 100 motors, were changed from series to shunt wound.

After the mill was placed in operation it was found that the right front sideguard which carries the manipulator was too heavy to be operated by the frame 100 motor which was connected in series with the back right sideguard motor. This problem was solved by coupling a second frame 100 shunt wound motor in tandem with the first motor, and connecting all three in series, thus securing enough torque to operate the sideguard with all three motors under current limit control. This could not have been accomplished so easily without the variable voltage control.

Two variable voltage motor-generator sets, each driven by a 750-hp motor furnish power for all of the aforementioned drives on the 54-in. mill. Like the 40-in. mill, all generators are 150 kw, 500/250 volts, except the two feed roll generators which are 30 kw, 200/100 volts, and all are rotating regulator excited. High peaks on these motor-generator set motors were lessened by putting one screwdown generator, one sideguard generator, two table generators, and one feed roll generator on each set (Figure 2).

The 5000-hp, 375-rpm, 3-phase, 6600-volt, 25-cycle, wound rotor motor on the 54-in. mill flywheel motor-generator set was replaced by an 8000-hp, 360-rpm, 3-phase, 6600-volt, 60-cycle, wound rotor motor (Fig-

Figure 2 — Variable voltage control for the 54-in. mill screwdowns, sideguards, front and back tables, and feed rolls.

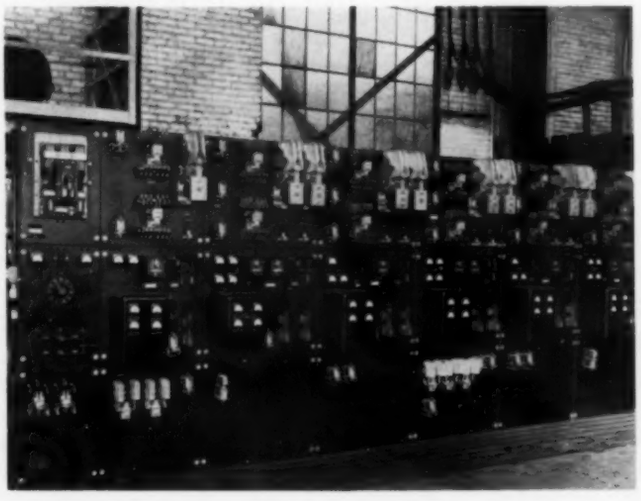
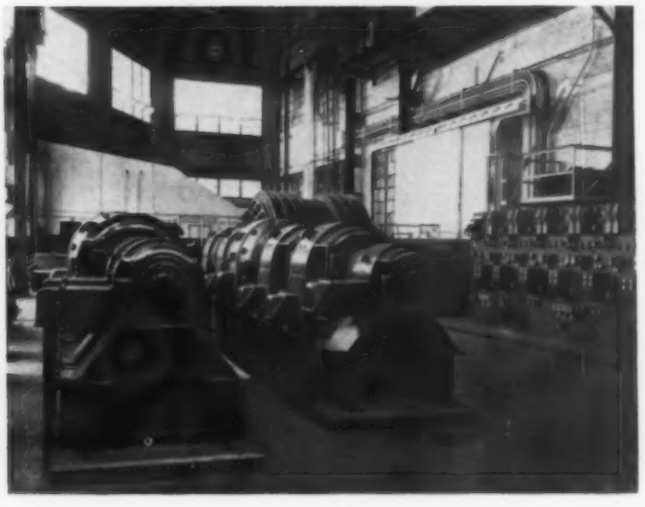


Figure 3 — The two variable voltage motor-generator sets for the 54-in. mill are in the foreground. The top of main mill drive is in the background.



ure 3). This new 8000-hp motor was installed on the existing bed plate without alterations except for some drilling for holding down bolts. It was determined that this was the largest size motor the existing bed plate would accommodate. Some consideration was given to the thought of installing a larger synchronous motor and removing the flywheel, but investigation showed that the peaks on such a motor would be higher than was desired on the power system. A new slip regulator was also installed with this wound rotor motor.

If an increase in production was to be realized, it would largely be obtained with this mill. For this reason, the old control for the drive generator and motor was replaced with a new exciter set and modern rotating type control, to obtain more rapid reversal and smoother control of generator volts and motor field current (Figure 4).

New pulpit control was also installed for the 54-in. mill, in a fully air conditioned pulpit equipped with sanitary facilities and tinted safety glass windows (Figure 5).

An interesting feature of the conversion of the 46-in. blooming mill to a 54-in. blooming mill was the necessity of raising the 7000-hp main mill motor 12-in. to allow for the wider opening of the mill rolls. This was done by raising as a unit the entire motor, including

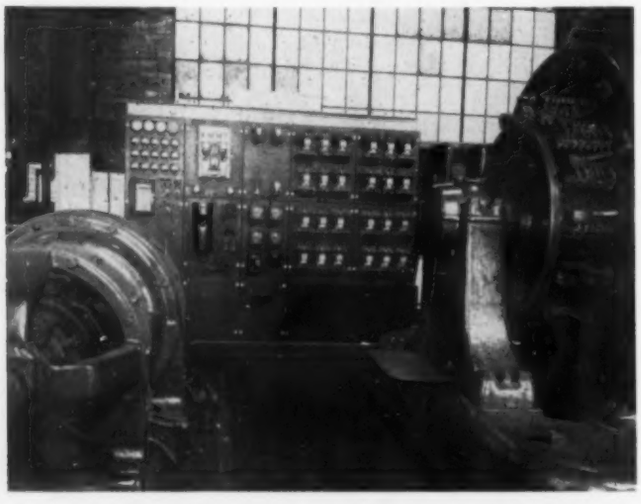


Figure 4 — The 54-in. mill main motor is rated at 8000 hp. View also shows generator field control panel.

Figure 5 — View shows 54-in. mill control pulpit.

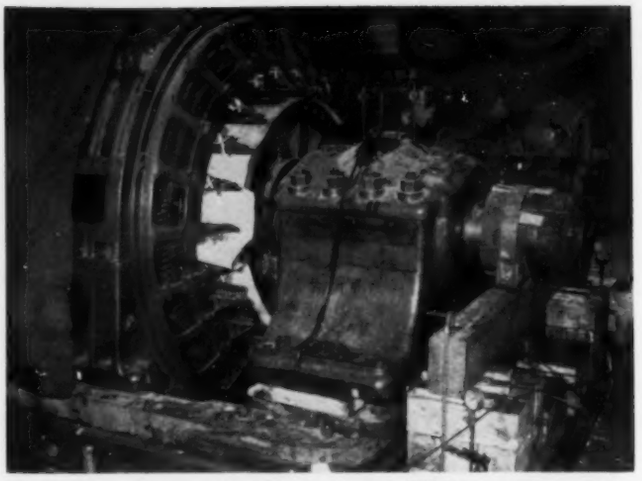


Figure 6 — One end of 54-in. mill, 7000-hp main motor shows motor raised 18 in. to the top position and 12-in. subbase installed in place.

bearing pedestals, rotor and stator frame, a total weight of 303 tons including the two lifting beams. Two steel beams, 12 x 18 in. were placed under each end of the rotor shaft and by means of four 250-ton hydraulic jacks, one under each end of these two beams, the entire motor was raised in approximately four-in. steps, a total of 18-in. Four pointers fixed to the lifting beams, one on each corner, each moving along a stationary gage, gave an indication that all four corners were moving up equally, and that the machine was level and plumb with the center lines at all times. A prefabricated steel base plate of four interlocking plates twelve in. thick was then inserted between the original cast iron base and the motor. The motor was lowered and bolted, through holes in the new base, to the old base plate. Sleeve nuts were used to bolt through the new base to the original foundation bolts. The new base was then grouted into a depth nearly even with the top of the new base, except for hand holes, to get to the bottom of the stator holding down bolts (Figure 6).

On the 40-in. universal slabbing mill the frame 412 feedroll motors were changed from series-wound to shunt-wound motors, with each of these motors driven by variable voltage generators, rated 50 kw, 500/250 volts. The speed of these feed rolls was matched to the table speed through reference tachometer generators. The two side screws for the vertical rolls, consisting of frame 416 motors, were changed from series-wound to shunt-wound and each driven by one 150-kw, 500/250-volt generator with rotating regulator excitation. New spindle shifting motors, frame 606, rated 25 hp, were also installed in place of the old frame 406 motors. The motor on the variable voltage motor-generator set for this mill was also made 750 hp to duplicate the others.

Where the change required new motors, it was decided to put all the a-c motor drives on 60 cycles. The reason for this was that 60-cycle equipment would be cheaper, more readily procured, and because the 60-cycle generation at the Pennwood power station had been expanded. A 34-kv outdoor substation was therefore installed. Referring to a paper presented before the Philadelphia section in January 1954, "Extensions to Electrical Generating and Distribution Systems at

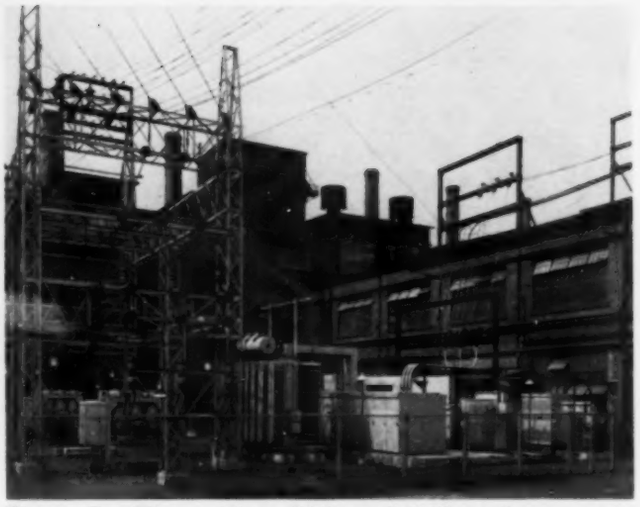


Figure 7 — The outdoor 34-kv substation shows power transformer, switchgear, 2300-volt and 480-volt unit substations.

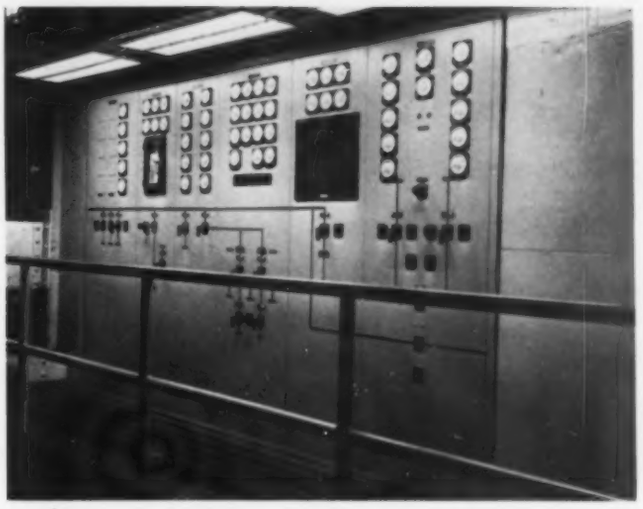


Figure 8 — Front view shows duplex panel for controlling 34-kv and 6.9-kv bus.

Bethlehem's Sparrows Point Plant," 1954 Proceedings AISE, we tapped the two 34-kv lines from the Riverside substation of the Consolidated Gas Electric Light and Power Co.'s system, and connected those to an outdoor substation, consisting of one 15/20 mva, 34.5/6.9-kv transformer with the necessary switchgear and duplex control. One 3000-kva unit substation consisting of two 1500-kva, 6900-volt to 2400-volt transformers, and two 1000-kva, 6900-volt to 480-volt unit substations was also installed (Figures 7 and 8).

The changes outlined have resulted in higher speeds on the screwdowns, sideguards and tables due to changes in the gear ratio, variable voltage, and better mechanical equipment. The screwdowns on the 40-in. mill and the 54-in. mill are alike and are capable of a maximum speed of 34.7 fpm with 1180 rpm on the motors at 460 volts. They are not, however, necessarily operated at this speed. This represents almost a 100 per cent increase in the 54-in. mill screwdown speed. Although the top speeds are higher than the speeds on rheostatic control, the main advantage of the current limit rotating regulator type of control is its instant response, both in starting and stopping, that is, better spotting control, which is an important requirement for a blooming mill auxiliary drive. The 54-in. blooming mill main motor was changed in its time of reversal at base speed, from approximately six seconds to four seconds. This time could have been made as low as two seconds, but it was not found to be necessary. Furthermore, there was better commutation on the generators at the slower reversing speed.

The operating and repair hours have been less per ton, and the table motor failures have been far less. The average power consumption in kwhr per ton has been slightly less than for the time preceding the change. The 54-in. mill, for the months October, November and December, 1954, broke all previous tonnage records for each consecutive month. It must be admitted, however, that there are many factors which enter into any set of figures on tonnages, besides the speed of the drives. Among these are size of initial ingot, size of the finished product, and perhaps most important, the heating of the ingots with proper facilities for feeding them to the mill.

SOAKING PIT IMPROVEMENTS

By H. C. Henschen

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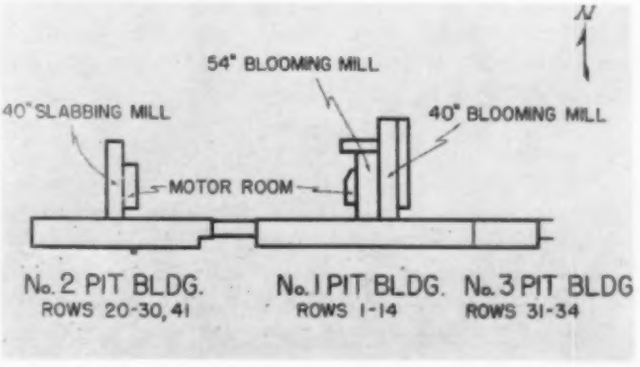
▲ MODERNIZATION of soaking pit facilities at Sparrows Point began in November, 1950 with the conversion of No. 20 row soaking pits. This was the beginning of a 3½-year period of "bee hive" activity which raised the total soaking pit hearth area by 50 per cent. This paper gives the history of the soaking pit expansion program and the results obtained.

The original Sparrows Point soaking pits were divided into three main groups (Figure 1). No. 1 pit building housed 7 four-hole rows of 6 x 8 ft regenerative pits, built about 1918, and 7 four-hole rows of 7 x 9 ft regenerative pits, built between 1924 and 1928. The smaller pits used slide dampers for reversal, and the larger pits used five-way, water-sealed valves. These pits were originally fired with producer gas, but had been converted to use 140-Btu enriched blast furnace gas in 1934. All of the pits in No. 1 building had natural

Figure 1 — Layout shows Sparrows Point's soaking pits and breakdown mills.



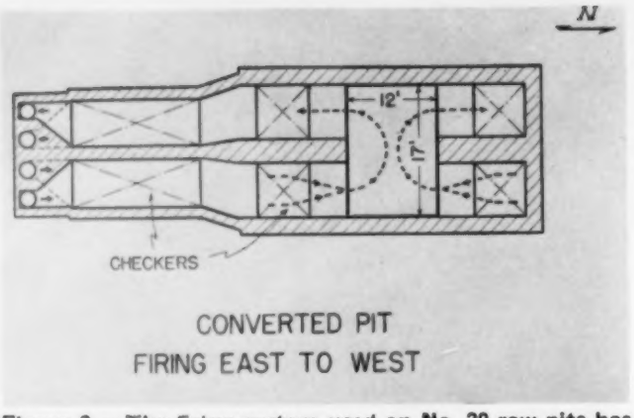


Figure 2 — The firing system used on No. 20 row pits has given excellent performance.

draft stacks and no fans for combustion air. Combustion controls were limited to automatic time reversal and gas-header pressure control.

No. 2 pit building originally housed 11 rows of regenerative pits built about 1933. These pits had four 7 x 12 ft holes in each row. All pits had ejector stacks with one fan supplying air for both combustion and draft on each two pits. Combustion controls were limited to automatic time reversal and gas-header pressure control. The fuel used was enriched blast furnace gas of about 107-Btu per cu ft.

No. 3 pit building was not involved in the conversion program. It houses 4 rows or 8 holes of fully controlled regenerative pits, each 9 ft 3 in. wide by 20 ft long.

The need for additional soaking pit facilities, which had been felt since 1948, became more urgent as ingot production gradually increased. Several schemes for increasing soaking pit capacity were considered. One scheme, involving conversion of the No. 2 pits, would have given a 7 x 16 ft pit in place of the 7 x 12 ft pit. This would have been accomplished by decreasing the thickness of the bridge walls. Although this change had been very successful at the Lackawanna Plant, it had to be abandoned at Sparrows Point because the additional 2 ft of pit on the south side would have been entirely out of reach of the soaking pit crane. Other proposals involved expansion to the east of No. 3 pit building and to the west of No. 2 pit building. Expansion to the east was discouraging because the distance to the mills was so great. Expansion to the west was limited by other buildings, railroad tracks, roads, and the shipyard. Expansion in either direction involved the costly extension of buildings, crane runways, and ingot tracks.

The most promising ideas involved removal of the 3 ft thick division wall between two adjacent pits, to form one large pit. This scheme, which had been successful in a few other plants, was quite easy to try in the No. 2 soaking pit building because each end of each pit already had its own flue, stack, gas piping, and air valve.

A sprung arch cover was considered for use on the resulting 12 x 17-ft pit. The 12 ft width of pit, however, would have necessitated an arch so high as to seriously limit clearance between the cover carriage and the pit crane. The cover was therefore designed to use Bethlehem's own type of suspended brick construction. Flat bar, welded around the circumference of the cover, was designed to seat in a sand seal when the cover was lowered.

The cover carriage, purchased outside the company as a unit, was equipped with a lifting mechanism powered by one 15-hp motor. Cover travel equipment on the carriage itself was not required because existing cable and drum movers on the balcony south of the pit could be adapted for use with the converted pit.

The problem of pit temperature control can normally be solved by either proportional-position control or two-position control. Proportional-position control could not be considered because it would have necessitated revamping the entire system of gas piping. This would have involved purchase of new gas valves and installation of additional orifices and metering runs. This type of control would have necessitated use of an air-to-gas ratio control, and metering of the combustion air in the ejector stack would have been very difficult. There has also been some doubt regarding the application of this type of control on regenerative heating furnaces. Therefore, two-position, band-type, on-off control was chosen because of its simplicity, low cost and adaptability to the existing stack system.

The heart of the stack control system chosen was the cylinder-operated positioning regulator. It was designed to accept one of three air pressures from solenoid valves and operate the windbox air gate and the butterfly damper.

The solenoid valves would be connected to a master reversal timer and an electronic potentiometer, on-off temperature controller in a conventional manner to complete this part of the control scheme. Other solenoid valves would be used to send air to open and close cylinder-operated gas valves at the correct time.

No. 20 row was chosen as the first pit to be converted because it was centrally located and could serve all three breakdown mills. With four checker chambers, four stacks, and four gas lines to each pit, a variety of firing combinations could have been used. A system

Figure 3 — Converted pits in No. 2 building have 50 per cent greater capacity.

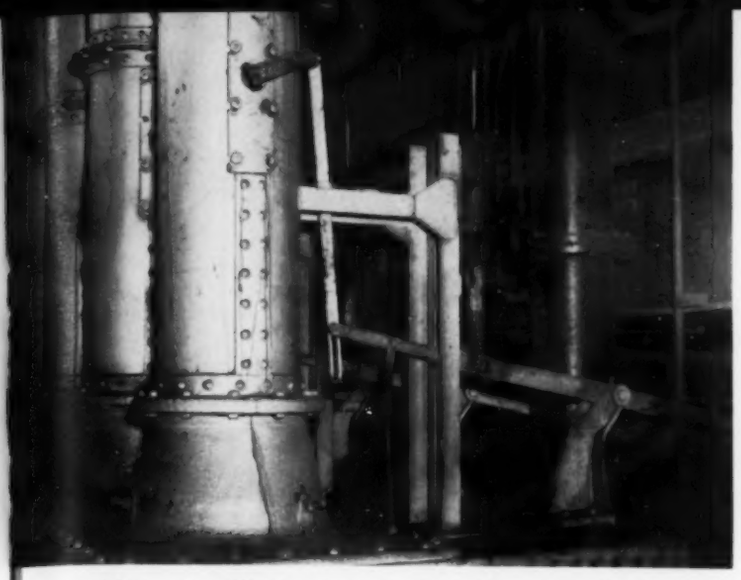


Figure 4 — Stack control mechanism for pits in No. 2 building.

was chosen which would force gas through the center of the pit in hopes of getting good heat distribution. Good distribution was immediately apparent. It was so good, in fact, that other firing combinations have never been tried, although only a simple manipulation of control piping was required (Figure 2).

Combustion was set by matching the desired gas flow with the proper air flow at the desired firing rate. A gas pressure regulator held the gas flow constant through adjustable stop type, cylinder-operated gate valves which had been saved from the original pits. The fixed fan speed and fan pressure held combustion air flow constant. No attempt was made to control the furnace pressure since available draft was insufficient.

The primary element installed for pit temperature measurement was a radiation tube sighting into the pit through an open end tube. This was unsatisfactory, because sometimes the radiation tube sighted on top of an ingot and sometimes it sighted on the bottom of the pit, depending on how the ingots were charged. This introduced serious errors in pit temperature measurement and was responsible for some washed steel. Almost immediately, a closed end target tube was substituted. This not only reduced the errors caused by the various ingot charging patterns, but also reduced the unpredictable effects of flame temperatures. Compressed air, supplied through a slack hose suspended from the balcony, was used to keep furnace gases out of the target tube and prevent fogging of the lens.

Performance of the converted No. 20 row was a pleasing surprise. It became apparent almost immediately that the ingot capacity of each converted pit averaged 120 tons or 50 per cent greater than the 80-ton average charge in a pair of the original pits. This compared with a hearth area increase of only 21 per cent. In addition, the record monthly tonnage increased 33 per cent over the record tonnage of the original pits. Monthly fuel rates dropped from 1,050,000 Btu per ton to 850,000 Btu per ton. Washed steel from these pits was practically non-existent and it was not necessary to clean out the pit bottom for months at a time. In view of all of the excellent results obtained, plans were made to convert other pits in No. 2 pit building.

One row of one-way fired soaking pits was being built at the west end of No. 2 pit building during the same time that No. 20 row was being converted. These pits added 770 sq ft of hearth to the 8350 sq ft then in service. Details of this construction will not be covered in this paper.

Interest in conversion possibilities in No. 1 pit building grew simultaneously with the success of No. 20 row. In the original 6 x 8 ft pits, for example, each 100 sq ft of building area under the pit crane housed only 4.2 sq ft of soaking pit hearth. A more efficient use of this space seemed highly desirable. Plans for conversion started with a simple removal of the 3 ft thick division wall, as in the case of No. 20 row. This would have produced two 15 x 8 ft pits in each row. With maximum hearth area as the prime goal, these plans quickly mushroomed into a design which would increase the original hearth area by 130 per cent. Each

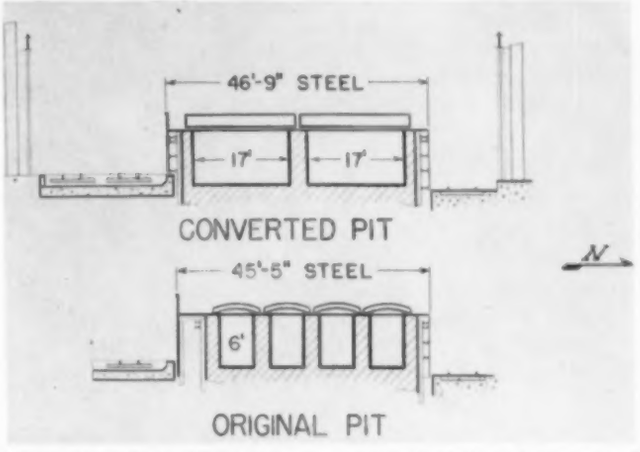
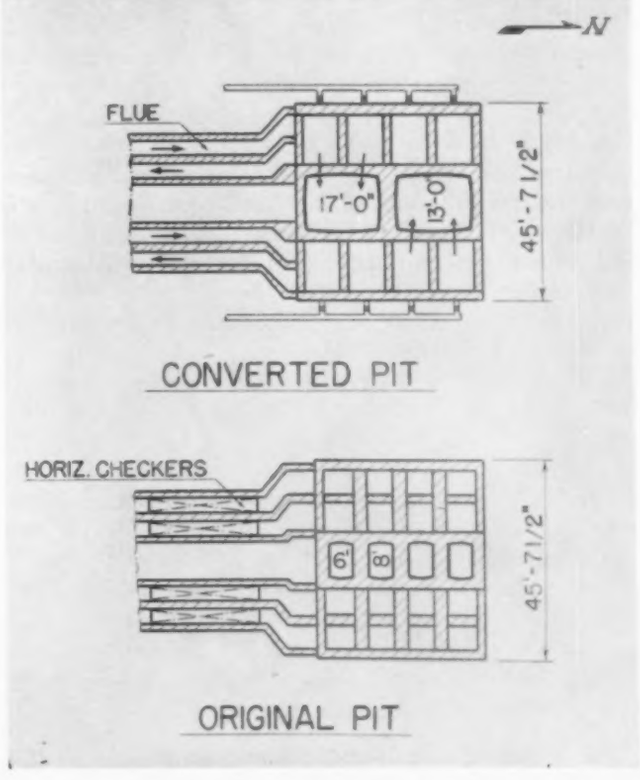


Figure 5 — Side elevation compares original and converted pits in No. 1 building.

Figure 6 — Plan view compares original and converted pits in No. 1 building.



100 sq ft of building area under the pit crane would then house 9.6 sq ft of soaking pit hearth.

Many compromises had to be made in order to get this much regenerative soaking pit hearth in such a small space. The pit could not be expanded to the north because of the limited space occupied by the hot ingot tracks. A southward expansion was limited to 1 ft-4 in. because of the already small space occupied by the cold ingot tracks. Two 17-ft long pits took up so much of the soaking pit island that very little room was left for walkways, instrument panels, and pit cover controls. The design of the north and south ends of the pits involved one compromise after another in an attempt to save precious space.

The advantage of having a pit the same size as the No. 20 row pits encouraged everyone to also think of expansions in an east-west direction. It was clearly evident that such expansion could only be made at the expense of checker chamber space. The pits had already become so large that the existing horizontal checkers would have to be removed to allow sufficient flue area for the products of combustion. Further reductions in checkers were therefore viewed with much suspicion. The problems seemed to resolve themselves as follows:

1. Pits 17 ft long by 13 ft wide should be built. The spare cover for No. 20 row pits could then serve as a spare for the proposed pits.
2. The most efficient checkers possible should be installed in the remaining space.
3. Preparations should be made to install tank type checkers outside of the soaking pit building if pit performance indicated the need for them.

Installation of standard soaking pit checkers with 2½-in. thick bricks would have given only 75 per cent as much checker heating surface area as the very excellent No. 20 row pits. However, using 2-in. thick bricks laid up to make 3½-in. sq holes would produce checkers having a total heating surface slightly greater than in No. 20 row. This design was chosen as the most feasible, although there was some hesitation when consideration was taken of the thin bricks and the small holes.

In direct contrast to the several firing combinations possible on No. 20 row pits, the converted No. 1 pits could only be fired one way. First of all, there were only two flues for each large pit. This meant that adjacent checker chambers in each pit had to be connected together. The loss of the "horseshoe" type firing of No. 20 row was regrettable but unavoidable. In addition to flue limitations, the space between adjacent pit rows was so small that only one gas line could be run to serve two pits. Therefore, a gas line firing "A" pit from the west during one part of the cycle would, after reversal, be switched to fire "B" pit from the west during the other part of the cycle. In like manner, a line on the other side of the row was firing "B" pit from the east before reversal and "A" pit from the east after reversal. The big disadvantage in firing this way is that adjacent flues are not under the same pressure and infiltration through flue division walls is possible.

The control scheme selected for the converted No. 1 pit emphasized simplicity. First of all, the space available on the soaking pit island was so small that only the pit temperature instruments, a few small electrical control switches, and one multipoint indicating gage could be mounted there. Two-position, on-off control with a radiation tube primary element mounted in the pit cover was chosen for temperature control. Combustion control was indirect with individual gas flow controls and air flow controls set to give the desired flue gas analysis at the desired heat input.

The furnace pressure control was a bit unusual. The furnace pressure regulator produced an output which varied with the draft required. This output was directed by two solenoid valves to either of two pneumatic stack-damper positioners. These positioners not only reversed the pit, but also dampened it for temperature control, and controlled its furnace pressure.

No. 6 row of pits was the first row converted in No. 1 pit building. Like No. 20 row, the pit performance was a pleasant surprise. The pits could be charged heavily and heated evenly in a relatively short time. The monthly fuel rate was 20 per cent lower than before. Tonnage heated in No. 6 row after conversion averaged 20,000 tons per month, compared with 10,000 tons per month in the original pits. Pit temperature controls were excellent and the pneumatic controls gave practically no trouble. A stack temperature of 750 F spoke well for the checker construction and completely erased any thoughts of the installation of tank type checkers which had been held as "an ace in the hole." Precious coke oven gas was saved because the pits would operate on 107-Btu fuel. Like No. 20 row, results were so encouraging that immediate plans were made for converting the other pits in No. 1 building.

This completed the semi-experimental and development stages of the soaking pit program. From here it was up to the construction people to keep the materials flowing to the sites and convert the pits with minimum inconvenience to the ever expanding pit operation. No. 20 row conversion was to have taken 26 days from "gas off" to "gas on," but it was completed in 15 days. At the end of the conversion program, only seven days time elapsed between "gas off" of the original pits and "gas on" the new pits. Sparrows Point's own laborers, bricklayers, iron workers, pipefitters, electricians, and fuel men combined their efforts to make "big pits" out of "little pits" in phenomenal time.

Soon, materials for conversion of nine more rows in No. 1 building began arriving. The job here was much greater than in No. 2 building because the entire original pit brickwork and steelwork had to be removed, the concrete mat resurfaced, and the new furnaces built from there. In the case of the pits with 5-way reversing valves, extensive excavation of the old individual flues, individual dampers, and reversing valves made conversion even more difficult. As in No. 2 building, conversion schedules were advanced from an original six weeks for No. 6 row to 24 days for No. 8 row. Surprisingly little inconvenience to the soaking pit operation was encountered in spite of the size of the operation.

Several yardsticks can be used to determine how well a plant's soaking pits can stand up to a production schedule. Pits which are required to heat 52 tons of steel per sq ft of pit per month are overworked and cannot be asked to absorb frequent or large surges in ingot delivery or rolling rates. Measuring in another

Figure 7 — The original pits in No. 1 building were 7 x 9 ft.

way, these pits would have had enough capacity to hold only 7.8 hours of mill rolling. To expect to increase the tonnage from 428,000 tons per month to 525,000 tons per month would have made it necessary to heat 64 tons of steel per sq ft per month or would have reduced the capacity to only 6.4 hours of mill rolling. The present pit capacity at Sparrows Point makes it necessary to heat only 44 tons per sq ft per month and provides capacity to hold 9.5 hours of mill rolling. The pits are not overworked, the quality of heating is good, few ingots ever stand on the track waiting for an empty pit, and fuel rates are 20 per cent lower than previous rates. On a recent mill repair day, the open hearth made 2100 more tons of steel than the mills rolled. Not a single ingot was banked, however, and the following day everything returned to normal with little effort. The soaking pit program at Sparrows Point has been very successful and is satisfying the plant's needs in every way.

DISCUSSION

PRESENTED BY

H. S. HALL, Assistant Manager, Combustion Control Department, Morgan Construction Co., Worcester, Mass.

H. S. Hall: We were primarily interested in Mr. H. C. Henschen's paper in which he covered the soaking pit improvements at Sparrows Point. We owe a great deal to the fuel department at Sparrows Point for their development of this method of firing their soaking pits.

I have seen considerable steel drawn from these pits and it certainly left nothing to be desired in the way of heating.

Mr. Henschen has given us some rather startling figures as to the performance of these pits which I am sure most everyone would do well to compare with their present soaking pit performance to see if they are anywhere near close to these figures.

To prove that this performance is not unique to Sparrows Point, I might add that there have been twelve holes of pits installed in other steel plants designed and fired in the same manner as the pits at Sparrows Point in which they are using high Btu gas as fuel and they are experiencing the same excellent heating results and overall pit performance as they do at Sparrows Point.

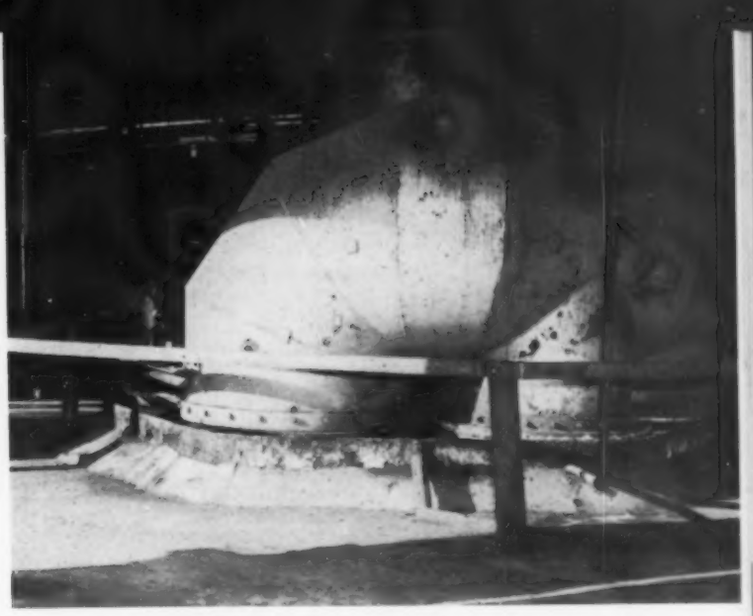
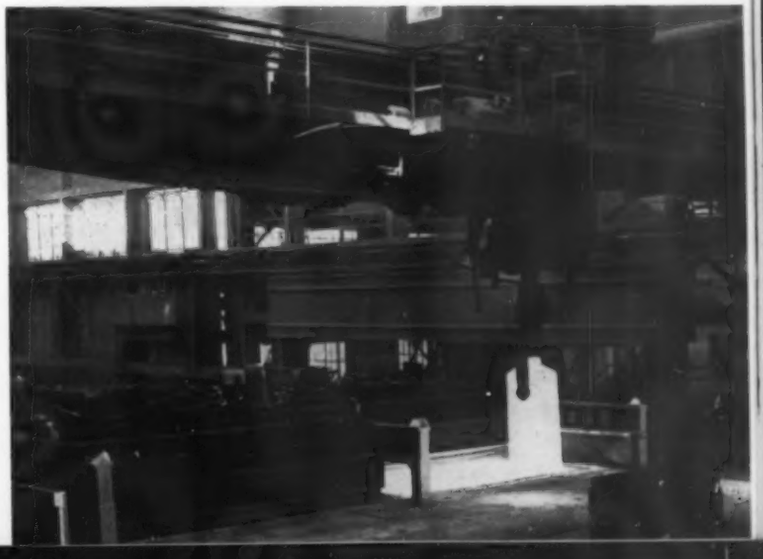


Figure 8 — One of the five-way, reversing valves used in the original No. 1 pits.

Figure 9 — Air piping, fans, and reversing valves used in the converted No. 1 pits.

Figure 10 — An ingot is being drawn from one of the converted No. 1 pits.



Transistors in the Metalworking Industry

By M. W. CANNON

Development Engineer, Industry Control Dept., General Electric Co., Roanoke, Va.

. . . . transistors have been marked by extremely rapid development, much faster for example than the vacuum tube . . . . they are finding use as components of regulating circuits to give more precise control of steel mill drives . . . . advantages are static operation, lower maintenance, and faster response . . . .

▲ IN the past two decades great progress has been made in all industry with relation to the types of products produced, but most important, with the speed at which the various types of products are being produced. In the early years after electric drives came into vogue, the first operating systems consisted of motors powered from constant potential buses and having their speeds varied by means of field control. These systems operated fairly well at low speeds, particularly on single-motor drives. However, any product that required going through several sequences of manufacturing process continuously, required storage loops or long distances between the various processes. Also, considerable operator manipulation of the speeds was necessary in order to maintain some semblance of synchronism between the various sections.

As the years went by and the demand for products became greater, and competition became stiffer, the operating speeds of the various drives were necessarily raised higher and higher. As the technical knowledge of the processes and various electrical components became better known, the first of the regulating systems came into being. One of the first of these regulators was the carbon pile rheostat, which controlled the field of the motor automatically by varying the field resistance as a function of speed. This first step permitted fewer operator manipulations and also permitted higher speeds of operation. However, this type of regulator is not very fast in operation and the speeds could not therefore be pushed too much higher than with the manual control. Therefore, companies soon started using the Ward-Leonard type of power system wherein the armature voltage was controlled alone or both the armature voltage and the motor field current were controlled. This step permitted machines to operate over a 10:1 speed range by armature voltage and up to 40:1 by armature voltage and field control. It also permitted faster response to changes desired by the operator.

From this point on, various types of regulators have been added to the basic generator and motor field controls, both to increase the accuracy of holding voltage or speed and to increase the speed of response to any type of change such as a load change, control voltage change, or a change desired by the operator.

A major step forward was made in the regulator field when the rotating regulator was designed. This type of machine, having two stages of amplification built in, permitted much higher accuracy, much faster speed of response to changes, and much higher operating speeds on the manufacturing processes than had ever been obtained before. The rotating regulator has been used in a great variety of regulating circuits for regulating speed, voltage, position, and others, from the time of its conception in the late 1930s up to the present day.

During World War II, the Germans made great progress in developing a new component for use in regulating systems—namely, the magnetic amplifier. The principles of the magnetic amplifier had been known for a great number of years, however, the types of steel available during the early days of the magnetic amplifier developments did not permit them to be used advantageously. After World War II, the United States did a great deal of research in order to develop high-quality steels for use in magnetic amplifiers. When the high-quality steels became available, the magnetic amplifier was used in several ways—as preamplifiers for rotating regulators or larger magnetic amplifiers, or as a direct exciter for generator fields or motor fields. The magnetic amplifier, when properly applied, can be a very important addition to the regulator component field. The main advantage is that it is completely static, thereby having no bearing, brush, or commutator maintenance to worry about. However, all types of magnetic amplifiers do have the disadvantage of bad wave shapes and a minimum speed of response equal to one-half cycle of the carrier frequency. Therefore, on the very high speed of response drives, this means that the main a-c frequency to be used on the amplistats has to be 360 cycles or above, requiring a separate source of high-frequency power. This is not too much of a disadvantage on large drives requiring a large number of magnetic amplifiers, but a smaller drive requiring only one or two presents a problem.

In the past two years a great deal of development has been done on a new and very promising component for regulating systems. This is the transistor. Since the original development, transistors have caught the fancy of a great number of industries—particularly the communications industry. The transistor is a semi-conductor device which at the present time consists of a piece of either germanium or silicon. The presently

available commercial transistors vary quite widely in power ratings from 50 mw and below up to about 60 watts of dissipation in the transistor itself. Typical output current variations will be from about 5 ma for the smallest transistor to 5 amp for the largest available transistor. Transistors can, in general, be grouped into two classifications—the point-contact and the junction-type of transistor. By far the greatest use in industrial regulating circuits will involve the use of junction-type transistors, and this paper is limited to that type.

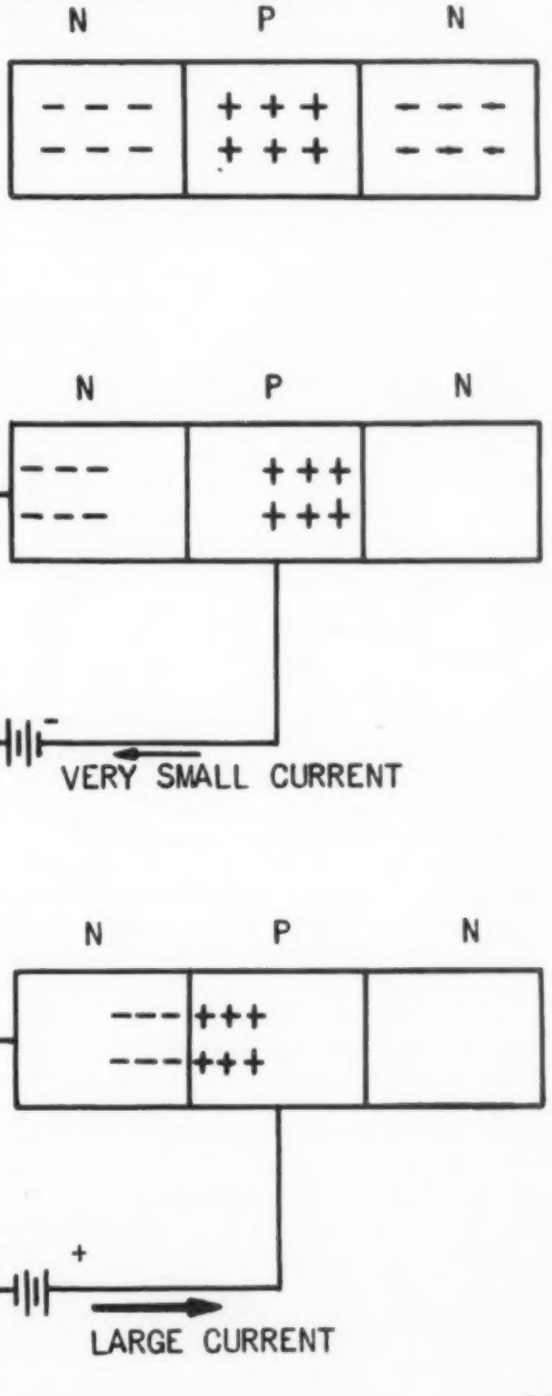
In order to understand the use of transistors, it might be well to discuss construction of the junction-type transistor. Let us also consider only germanium at this time. The copper-oxide, selenium, or germanium rectifier is also an example of a semi-conductor device. Essentially, the transistor consists of two rectifiers back-to-back. Figure 1 shows a typical construction of a junction-type transistor. You will notice it consists of three zones of germanium, one we call a P type, the other two are N type. "N" means that the material has some electrons that are not tightly bound into the atomic structure, and therefore, if influenced by an outside force, can be pulled away from the basic atomic structure, and are therefore free to move. Conversely, "P" means a type of material whose atomic structure has a deficiency of electrons or contains "holes."

The junction between the "N" material and the "P" material is a semi-conductor rectifying barrier. If a d-c voltage is applied between the "N" material and the "P" material, with the positive polarity on the "N" material, the electrons are not free to move across the barrier and therefore only a very small leakage current will flow. But if the voltage is applied with the plus polarity to the "P" type material, electrons can easily flow across the barrier and therefore a large current flow will result. With this type of battery arrangement, the resistance of the barrier is very low, and a large flow of current will result with a low battery voltage. Now if a battery of higher voltage is connected between the other "N" type and the middle "P" type, with the plus polarity on the "N", and a load resistor is connected in series, we have the arrangement shown in Figure 2, which is the basic transistor-amplifier circuit. Now the flow of electrons caused by the low potential battery in the conducting direction of the transistor will produce a current flow through the "P" to the "N" type connected to the higher potential battery by diffusion through the base to the high voltage barrier.

Each of the sections of the transistor has been assigned a name. The conducting side is called the emitter, the middle section is called the base, and the blocking side or non-conducting side is called the collector. The current flow in the collector and load resistance portion of the circuit is usually a pretty high percentage, ranging up to 98 or 99 per cent of the current flow that is occurring in the emitter circuit. It can, therefore, be seen that the voltage and power gain between the emitter circuit and the collector circuit is very high, since the emitter circuit battery could be of the order of a tenth of a volt, yet the collector circuit battery might be of the order of 60 volts. Therefore, a voltage gain of about 600 would be obtained from such a circuit. Other transistors are constructed having a section of "N" type material between two "P" type materials. Here the operation is exactly the same as just described, except that the emitter and collector battery polarities are reversed.

Transistor circuits can be arranged in three separate ways. The one just described is called the common base circuit, the other two are the common emitter circuit and the common collector circuit. Each circuit has its own particular application and characteristics. The common emitter circuit seems to have the most desirable characteristics for most industrial work and will in most cases be used extensively in this type of work. It can be seen from Figure 2 that the common emitter circuit gives essentially a current and power amplifier rather than a voltage amplifier, as was obtained in the

Figure 1 — The junction type transistor essentially consists of two rectifiers back-to-back.



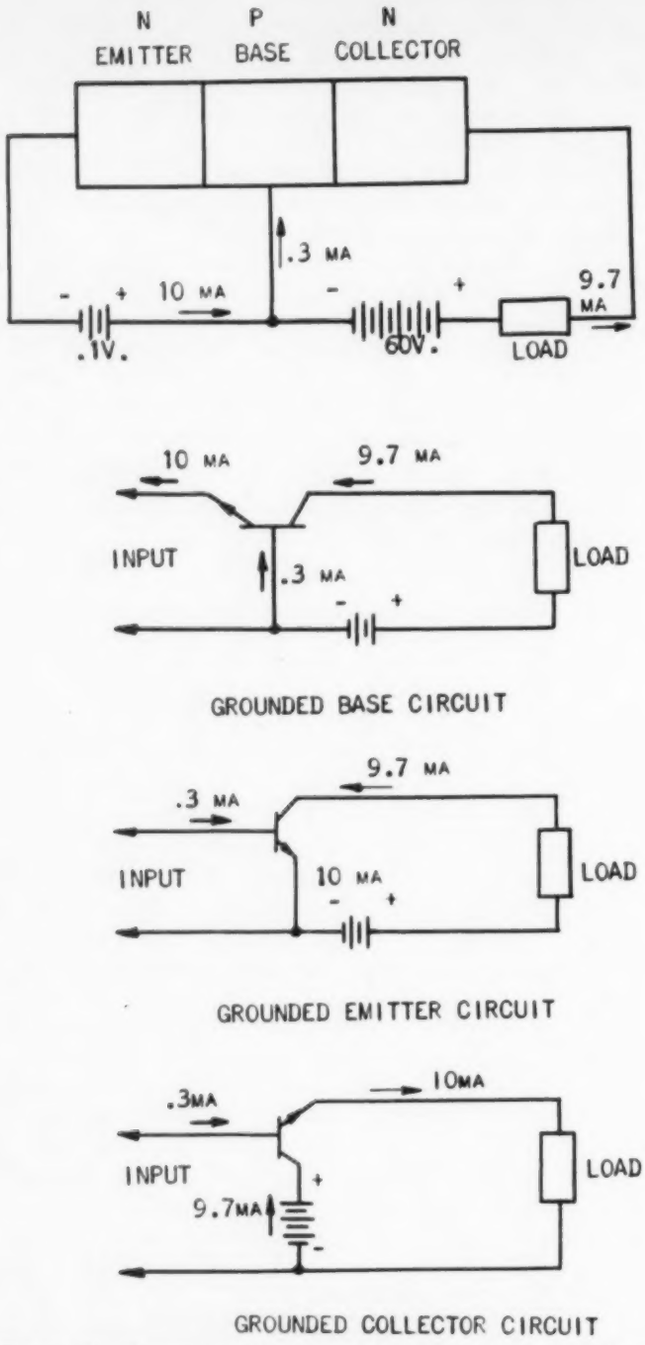


Figure 2 — Several common types of transistor circuits are given in this schematic diagram.

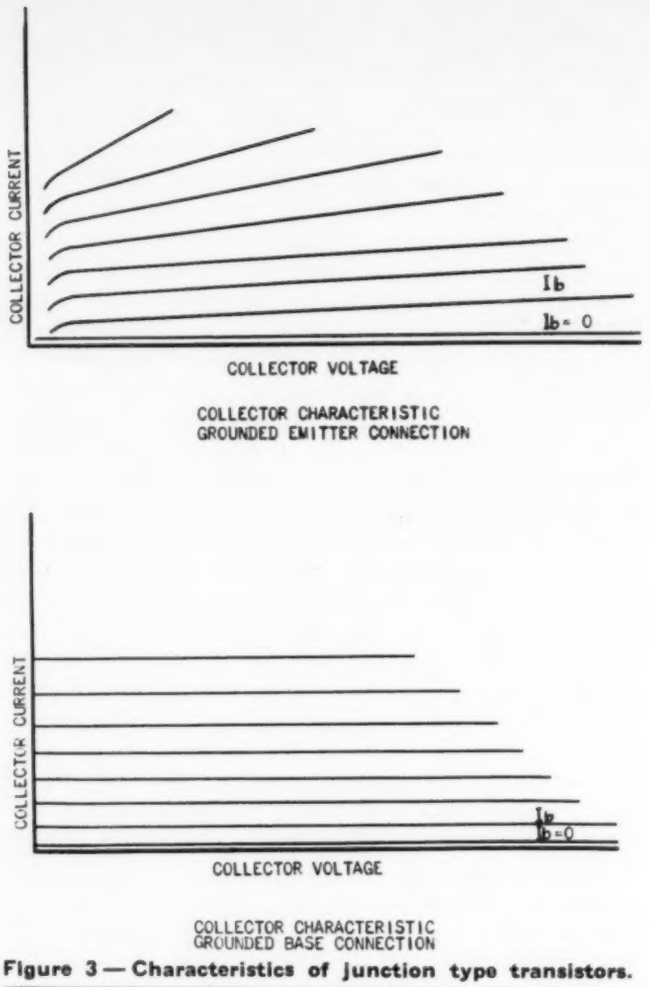


Figure 3 — Characteristics of junction type transistors.

common base circuit. Characteristic operating curves of the transistor can be taken as shown in Figure 3.

It might be well now to look at the advantages and disadvantages of the transistor as a regulating component. These are listed in Table I. By far, the greatest disadvantage shown in the table is the change in parameters and the change in I_{co}, which is the collector current with no emitter current flowing, with changes of temperature. These changes would appear as a drift in the regulator, or in other words, the speed or voltage or position that was being regulated would change from what was actually desired. However, if the gain of the regulating system is fairly high with respect to the amount of change in characteristics, the overall results would be fairly minor. In addition, as transistors are improved, the I_{co} current becomes smaller and smaller, and will, therefore, have less effect in the overall results.

Silicon transistors have the added advantage that the I_{co} is so low at normal operating temperatures that the temperature drift effect is not noticed appreciably.

Since the advantages of transistors seem to more than outweigh the disadvantages, why have not transistor circuits been applied to a great extent in the metalworking industry? As in all new components, when first developed there are always many problems in trying to mass produce them. Transistors are no exception.

In order to be used generally, the components involved must be manufactured so as to maintain close tolerance of their characteristics. If a dozen transistors are used in the same type of circuit, it would be to the advantage of everyone concerned to have the transistors matched so that the other circuit components, such as resistance, capacitance, voltages, would not have to be individually tailored for each transistor. The first transistors manufactured were not like this. Each circuit had to be tailor-made to fit the transistor. Also, other problems of manufacture, such as the very minute size of the piece of germanium used, required special techniques. The germanium junctions were found to be very susceptible to moisture and chemical contamination, with very detrimental effects to the operation. A large number of these mechanical difficulties have now been fairly well corrected, so that the transistors now being manufactured are consistent in characteristics. The major portion of them are her-

metically sealed and very carefully manufactured to prevent contamination during the actual manufacturing processes.

The characteristics of transistors seem to be well suited for communications work, thus the major portion of the initial research and development has been aimed in that direction. The high frequencies encountered in communications work naturally dictate a small size of semi-conductor device, and fairly small wattage dissipations. Communications work also means large volumes of transistor business—say, in the millions of transistors a year—whereas in the industrial field regulating circuits would require an insignificant number of transistors. However, at the present time there is some development work being done on larger size transistors. Some are now commercially available in the watts size instead of milliwatts as the first units were designed. One major problem to be overcome in the larger size transistor is cooling. Even the larger size transistors now available in the watt ratings are still very small pieces of germanium or other semi-conductor (perhaps 0.02 sq in.) whereas the milliwatt size might have a piece of germanium about 1 mm square. The problem of dissipating wattage in such a small piece of material and getting heat transferred away from the material is a huge although not insurmountable problem.

Three other problems in using transistors for industrial regulating circuits consist of price, life, and the training of engineers in the design of the transistor circuits. Price will automatically take care of itself as the rate of production increases. The training of engineers in the use of transistors will also come into being, as more and more reliable transistors are obtained for development work in the industrial laboratories. The life of transistors is more difficult to determine in that a life test is very difficult to speed up on a transistor. A contactor or relay can be operated at a high speed and, therefore, the number of mechanical and electrical operations corresponding to possibly 5 to 10 years of normal operation can be obtained in a relatively short time. However, it is difficult to determine if a transistor has a 5 to 10 year normal continuous operation unless it is operated for 5 to 10 years. The problem of running an accelerated life test on such a unit is being studied in the laboratories, but whether the answer will be correct remains to be seen. Essentially, if a transistor unit is non-contaminated, hermetically sealed, and is not operated at such a temperature as to melt down the semi-conductor material, there seems to be no reason why the transistor life should not be indefinitely long.

TABLE I
Transistors as Regulating Components

Advantages	Disadvantages
1. Small physical size.	1. All parameters especially I_{co} temperature sensitive.
2. Good wave shape.	2. Low input resistance.
3. Linear characteristics over a reasonable range.	3. No isolation between input and output.
4. Inherent long life.	4. Requires input current.
5. High gain.	5. High internal power dissipation.
6. No warm up time.	
7. Rugged.	
8. Operate on low voltages.	
9. High frequency response.	

Perhaps the best known present-day use of transistors is in the hearing aid industry. Transistors were a natural for this type of operation since they are looking for extremely light weight, so that the wearer is not loaded down with equipment, both in the unit itself and in the associated battery equipment. Portable radio sets utilizing transistors are now commercially available. And one can read in the newspapers accounts of various laboratories demonstrating small portable radio transmitters, oscilloscopes, and all manners of equipment utilizing transistors.

What might be some of the possible applications for transistors in the metal working industries? These might be broken down into three general categories. The first might be small independent circuits; the second, comparing and preamplifiers; the third, a complete comparing and amplifying component of a regulating system. One of the examples of an independent circuit might be the load relay, which now operates as a function of load on a stand of a rolling mill. The transistor could operate directly off the shunt reading motor armature current, and operate to pick up a relay as a function of some specified load setting. This relay then could initiate some sequence of the finishing process. Another such application might be the use in photoelectric devices for counting or for initiating operating sequences or for regulating purposes, such as loop controls. The transistor being small in physical size and not requiring much standby power, could conceivably be mounted directly with the photoelectric detector, thus eliminating entirely the long runs of shielded cable sometimes now required. Another such circuit might be used in the preset motor-operated rheostat controls where the operator pre-selects the speed at which his drive will operate before starting the drive.

In the second category the transistors are used as comparing and pre-amplifiers for magnetic or rotating regulators to increase the accuracy and the speed of response of a particular regulating system. Here transistors offer an ideal solution of the problem in that their speed of response is extremely high, most units being responsive to frequencies in the kilocycle range, and some even in the megacycle range. These frequencies are very much higher than anything needed in industrial regulating circuits. Transistors are also excellent amplifiers to use ahead of magnetic amplifiers, since their high impedance output will hold any circulating currents due to induced a-c voltages in the control fields of the amplifiers down to a minimum, which is very desirable.

When larger transistors become available, it is conceivable that they can be used as comparing amplifiers in regulating circuits where the transistors would drive an exciter or possibly a generator field directly. This would be a major step forward in regulating circuit work.

Transistors are progressing rapidly in development. At their present stage, they have been developed very, very much faster than electronic tubes were ever developed. If this progress continues, we shall see in the very near future transistors used singly or in conjunction with the present components of regulating circuits to improve the operation of steel mill drives and to reduce the maintenance cost involved.

Operating experience with use of cast steel work rolls in hot strip mill finishing stands hints that accumulated heat and temperature are some basic factors leading to selection of steel over iron work rolls.

Cast Steel Work Rolls in hot strip mill finishing stands

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▲ OVER the past five or six years, operators of certain hot strip mills have been having considerable success in replacing the 2½ per cent nickel or 4½ per cent nickel cast iron double poured roll, with a cast alloy steel roll in the early stands of the finishing train.

Those who use steel rolls claim less mill downtime, and that the steel roll can be kept in the mill two to three times as long as the iron roll before surface roughening requires its removal. This undoubtedly increases the yield on the particular mill. Some operators cannot use the steel roll on high carbon strip because of the relative softness of the steel roll, which is about 20 to 30 Shore scleroscope points below the hardness level of an iron roll. This softness is claimed to cause grooving and tail marking.

There are several characteristics which differentiate the steel roll from the iron roll.

1. The steel roll develops a shallow, fine fire crack pattern which may help to break up the scale.
2. The steel roll expands to a greater extent in the mill and sometimes requires a negative crown to compensate for this expansion.

This substitution of the cast steel roll for the alloy iron roll has not been successful throughout the entire hot strip mill industry. A survey made in the last three months by our company on the use of cast alloy steel rolls in thirty hot strip mills gave the following information:

11 use steel rolls in the first and second finishing stands.

10 have tried steel rolls and found no advantage.

3 have trials in progress on cast alloy steel.
6 have not tried cast alloy steel.

Thus, only about two-thirds of the hot strip mills have thoroughly tried out steel rolls, and only half of those who have tried them have found any advantage and adopted them as standard practice. With such a division as this, it can easily be seen that there is room for much controversy and discussion.

Of the ten mills in the survey that do not use steel rolls after trying them, eight state that iron rolls do as well as steel; one claims iron rolls do better; and one claims that the increased cost of the steel roll is not justified.

A further breakdown of the hot strip mill survey may be of interest. This breakdown consists of dividing the mills into two groups:

1. The first group may be termed the "conventional" mills consisting of four stands of continuous roughers with scale breakers.
2. The second group may be termed "unconventional" mills, which have some other arrangement than the conventional straight-away roughing train. Usually, this unconventional group is characterized by having a 2-high or a 4-high reversing rougher; but there may be a 3-high in combination with a 2-high rougher or some other unconventional roughing combination. The main point is that the second group has roughing stands which slow up the time between flats being fed to the finishing trains.

In the "conventional" mill classification:

19 mills were included in the survey.
9 mills are using steel rolls in the first two finishing stands.
5 mills do not use after a fair trial.
2 mills have a trial in progress.
3 mills have made no trial.

Thus, nine mills out of fourteen in the first group that have tried steel rolls have adopted them as standard practice.

Turning to the "unconventional" mills:

11 mills were included in the survey.
3 mills are using steel rolls in the first two finishing stands.
5 mills do not use steel rolls after a fair trial.
3 mills have made no trial.

Thus, three out of eight "unconventional" arrangements use steel rolls.

In other words, 65 per cent of the "conventional" mills that have tried steel rolls in the early finishers continued to use them; while only 37½ per cent of the "unconventional" mills use steel rolls after having tried them.

Now, the big difference between the two groups from an operating point of view is the speed at which the bars are continuously fed to the finishing train. In the first group, the bars are usually fed to the finishers almost end to end, which gives very little time for the finishing rolls to cool off between slabs. In the second group, there is usually a waiting period before the hot bar comes from the rougher to the finishing train, allowing the first finishing rolls to cool. It is significant that one of the three "unconventional" mills using steel rolls reports poor water facilities. Thus, accumulated heat seems to be one of the basic factors in the use of steel over iron work rolls in the early finishing stands of the hot strip mill.

Some calculations made by the writer show that the strip in No. 1 stand finisher is in contact with the roll 52 times as long as in No. 6 stand finisher; and, besides this, the entering bar is considerably hotter in the early position. There seems to be no question that the early stands of the finishing train are subjected to much higher temperature than the final stands. Dr. Peck, in his work on the effect of temperature in roll breakage, has estimated a surface temperature as high as 1500 F in the portion of the iron roll in contact with the hot metal in the second finishing stand. Since the steel rolls have never been reported as being much used beyond the third finisher, here, again, we find evidence that heat is a factor in the choice between steel and iron rolls.

Use of cast alloy steel work rolls has been limited to early stands of the finishing train.

Application of Tunnel Type Furnaces to steel mill use

. . . . operations with the tunnel type furnace have proven its adaptability to steelmaking uses . . . . design has inherent advantages in material handling where costs have been kept to a minimum . . . . in billet furnace, heating has been excellent and scale losses have been cut . . . . cars can also be worked on without shutting down furnace . . . .

PART I

MECHANICAL AND MATERIAL HANDLING FEATURES

By J. T. COOK

Assistant Chief Engineer

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The Timken Roller Bearing Co.

Canton, Ohio

▲ OUR company recently put into operation two furnaces patterned after the tunnel type kilns used in the ceramic industry. Tunnel type furnaces, while widely used in the ceramic industry, are not generally found in steel mills. This paper will describe these furnaces with particular emphasis on mechanical features and the methods of handling of materials.

One of the most difficult problems to be solved in the design of an industrial furnace is the problem of moving material into, through, and out of the furnace at minimum cost. The ceramic industry has developed a very successful solution in the use of the tunnel kiln. This furnace consists of a long refractory tunnel with burners in the sides and with a bottom made up of moving cars upon which the material being heated is placed. The loading and unloading of the cars takes place outside the furnace where handling equipment and personnel are not subject to furnace heat. The heating operation is continuous as the cars are moved through the furnace. The mechanical equipment required for moving the cars is not exposed to furnace heat, thereby minimizing maintenance.

Our company had considerable experience with tunnel kilns during the years of World War II and the Korean War. The demand for annealed bars and tubes exceeded the capacity of the company's annealing furnaces. To supplement the existing capacity, the company contracted with a ceramic producer in the vicinity for the use of an existing tunnel kiln which had been built for firing ceramic ware. Steel was trucked to the ceramic plant where the actual operation of the kiln was handled by the contractors personnel. The required annealing cycle was specified by our company. The results of this operation were very satisfactory, indicating the adaptability of the tunnel kiln to steel mill use.

Figure 1 — General view of tunnel type billet heating furnace shows charging equipment.

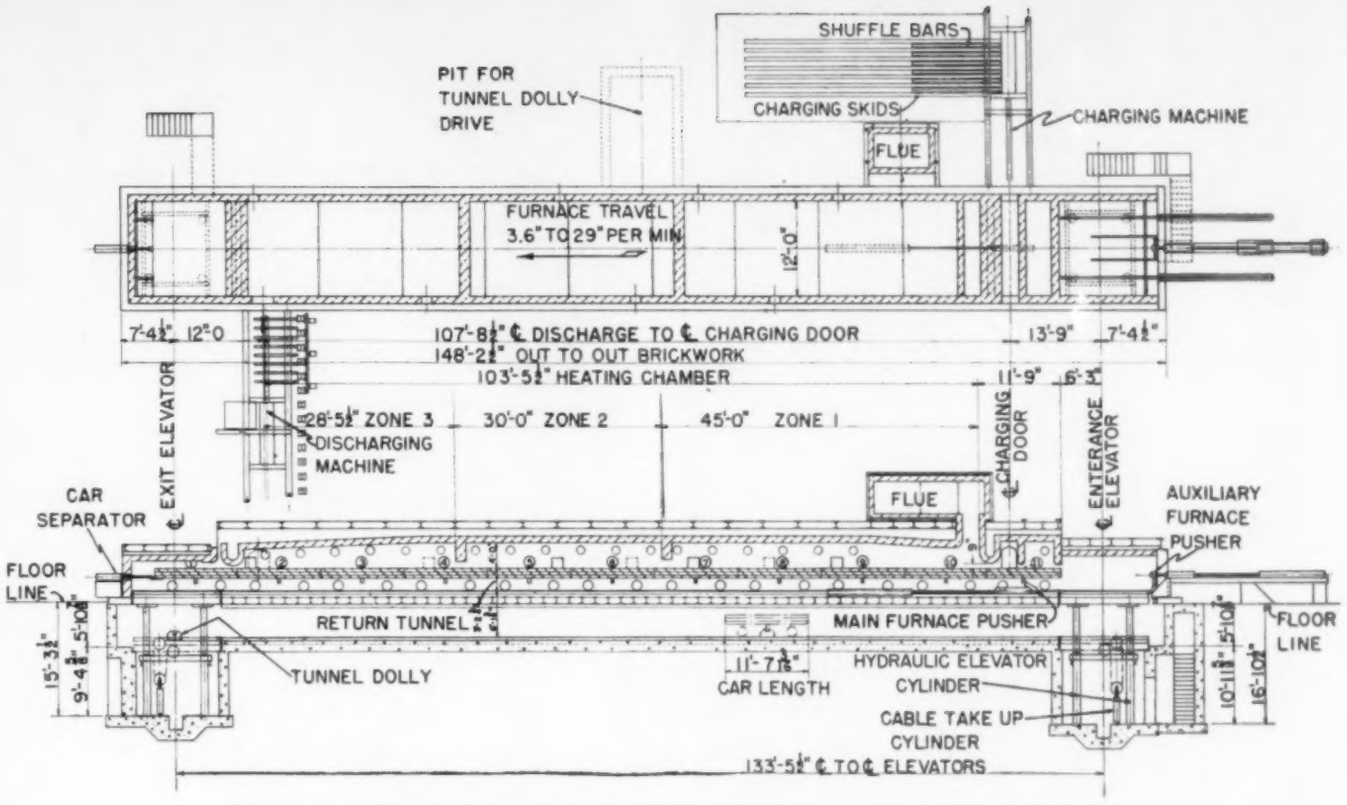


Figure 2 — Plan and longitudinal section of tunnel type billet heating furnace.

The first tunnel type furnace installed by us is used to heat round billets for piercing at a seamless tube mill. The second is used to anneal bars, billets, and tubing.

BILLET HEATING FURNACE

In 1950, the company undertook an extensive program for the improvement and modernization of the existing seamless tube mill in its Canton, Ohio plant. One phase of the program consisted of the replacement of the old roll down billet heating furnace with a modern furnace with twice the heating capacity.

Several types of furnaces have been used for heating round billets prior to piercing. The roll down and the rotary hearth furnaces are the types most commonly used. At one time, all the company's three seamless mills were equipped with roll down furnaces. Two have been replaced by rotary hearth furnaces and one by the continuous tunnel type furnace described in this paper.

After considerable study, taking into consideration the favorable experience gained in annealing in a tunnel kiln, it was decided that the new furnace would be patterned after a tunnel kiln. Considerable departure from the design of a conventional kiln was required to meet the needs of a furnace for heating billets for piercing. The basic idea of using a moving hearth made up of a series of cars was retained. This not only provided a means of moving steel through the furnace, but, also, made it possible to repair the hearth without a long delay. A spare car could be substituted for a defective car. The straight line design of the tunnel furnace does not use as much valuable floor area as would be required by a rotary furnace.

Furnace description—The new furnace looks much like a conventional furnace from the exterior, Figure 1. The main difference from a conventional steel mill furnace is the use of furnace cars to form a traveling hearth for moving the billets being heated through the furnace. Figure 2 shows a plan view and longitudinal section through the furnace.

In order to conserve the heat in the car decks, it is essential that the cars be returned rapidly from the discharge to the charging end of the furnace. This is accomplished by the use of a return tunnel directly under the furnace. Elevators are provided for lowering the cars to the return tunnel level at the exit end and raising them to the furnace level at the charging end.

The construction of the furnace can be better visualized by referring to a typical cross section, Figure 3. The furnace proper is above the floor line. The furnace heating chamber is formed by refractory walls, a suspended refractory roof, and a refractory hearth. The refractory decks on the furnace cars form the hearth. The billets being heated rest on refractory rails on the car decks. The furnace walls do not run all the way down to the floor. Space is provided under the walls for air circulation to prevent over heating and running gear of the cars. Air ducts are provided under the cars to aid the cooling.

The cars are carried by four single flanged wheels running on railroad rails and turning on tapered roller bearings. The cars are 11 ft-9 in. long and 12 ft-0 in wide. The weight of each car is 13 tons, not counting the weight of the charge. The space between the car deck and the wall is protected by the overhang of the walls and a sand seal is provided to prevent infiltration of air.

The furnace is fired by burners which are placed in the side walls 3 ft above the car decks. The roof of the furnace is 4 ft above the decks except at the ends of the furnace where it is lowered to control the flow of the products of combustion.

The return tunnel is 6 ft 1¾ in. below the furnace track level and is located below the floor line. The furnace is supported on hearth beams which span the space between the foundation walls, thus forming the return tunnel. A track runs the length of the return tunnel. Between the return tunnel rails is a track for the return car puller which is referred to as the tunnel dolly.

Again referring to Figure 2, it will be noted that the furnace is a long tunnel divided into a series of chambers by hanging curtain walls. Starting at the charging end of the furnace, they are as follows:

1. Entrance vestibule—to minimize loss of heat from car decks.
2. Preheating chamber—to reheat car deck.
3. Charging chamber—where billets are charged.
4. Heating chamber—103 ft-3½ in. long which is divided into three chambers; one for each zone.
5. Exit vestibule—to minimize loss of heat from car decks.

At the charging end of the furnace, there is a hydraulic elevator supported on four cylinders which are equalized mechanically. This elevator raises the furnace cars to the furnace level and a provision is made so that the elevator can raise an additional 1 ft-6 in. to a repair track which is used to change furnace cars. A similar elevator is installed at the discharge end for lowering empty cars to the return tunnel.

Billet handling—All of these unconventional features are required to make a continuous moving hearth for transporting steel through the furnace with a minimum of effort. As far as material handling is concerned, the operation is like a rotary furnace straightened out from a circle to a straight line.

The billets are brought to the furnace by overhead crane and placed on inclined charging skids, Figure 4. They roll down these skids onto shuffle bars which move them forward to a kickout mechanism which puts one billet at a time onto a conveyor which moves it up to the charging position. The billet is lifted up and moved into the furnace by a tong type charging machine which runs in and out of the furnace on an over-head runway. Billets can be charged either single or double row. The charging operation is automatic.

The billets being heated move through the furnace

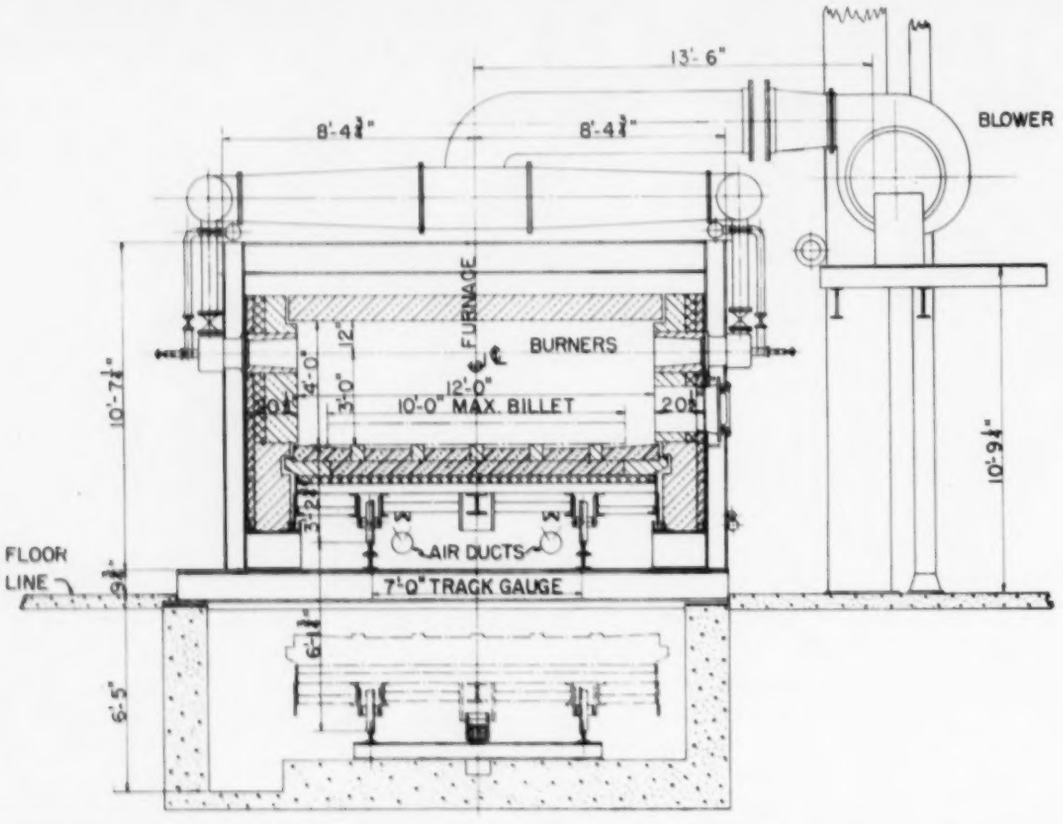


Figure 3 — Typical cross section through tunnel type billet heating furnace.

Figure 4 — Charging for tunnel type billet heating furnace is automatic.

Figure 5 — Discharging machine at tunnel type billet heating furnace is manually controlled.

carried by the furnace cars without further attention. The speed of the furnace train is adjustable from 3.6 to 29 in. per min, giving a heating time of ¾ to 6 hours depending on heating requirements.

Upon reaching the discharging end of the furnace, the heated billets are extracted one at a time by a discharging machine, Figure 5. This machine is manually controlled by the discharge operator. The machine is similar to the charging machine except that the tongs can be slewed and are water cooled. The billet is dropped by the charging machine onto skids and it then rolls onto a roller table which conveys it to the centering machine and piercing mill.

A television camera is provided at the charging end which is properly aimed to show the operation of the charging machine. The monitor for the set is placed in the discharge pulpit, Figure 6, so the discharge operator can see that the charger is functioning properly. In case of trouble, the operator can call over an intercommunication system to the stocker to straighten out the trouble. Thus, one operator performs both charging and discharging functions.

Car handling—One of the most difficult problems encountered in the design of the furnace was the automatic movement of the furnace cars. The various parts of the system are shown in Figure 2.

The cars are moved through the furnace by the main furnace pusher, with a dolly equipped with a latch or dog, which engages a lug on the bottom of the last car of the train. It is operated by a hydraulic cylinder. This pusher is located between the rails, under the furnace train at the charging end.

An auxiliary pusher is provided which moves the cars off the entrance elevator and pushes the entire train while the main pusher returns to its starting position. It is actuated by a hydraulic cylinder and is located outside the furnace at the charging end.

At the exit end of the furnace, there is a car separator which pulls the forward car away from the train onto the exit elevator. It is also operated by a hydraulic cylinder.

After the car is all the way onto the exit elevator, the elevator lowers the car to the return tunnel level where

Figure 6 — The monitor for the television set is placed in the discharge pulpit so the discharge operator can see that the charger is functioning properly.

it engages the tunnel dolly which is properly positioned to receive the car.

The car is pulled through the return tunnel, Figure 7, onto the entrance elevator by the tunnel dolly. The tunnel dolly is moved by a cable which is driven by a winch, powered by a d-c motor which is controlled to give proper acceleration and deceleration to the car.

Figure 7 — View shows car in return tunnel. A man is shown to illustrate relative size, but he would never be in the tunnel while the furnace is operating.

At the entrance end, the car is raised to the furnace level by the entrance elevator. About four minutes are required to move a car from its position at the forward end of the train back into position at the rear of the train at the charging end of the furnace. The forward travel of the train continues without stopping while a car is being moved from the discharge back to the charging end.

The movements of the train and return of the cars are automatic. They are controlled electrically through suitable limit switches, relays, and interlocks.

Provisions are made so that if any operation fails to take place in its proper sequence, the furnace train will stop to prevent wrecks. The speed of the train is adjustable. It can be started and stopped at any time by the discharge operator to suit mill operations.

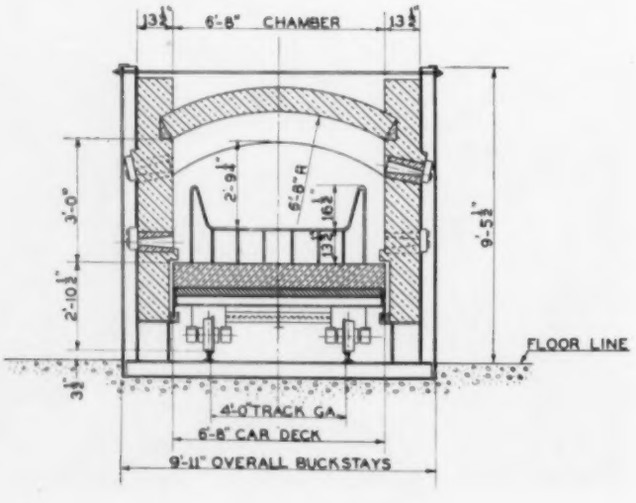
All the hydraulic equipment required for the car movements including the elevators, pushers and car separator are supplied by a central hydraulic unit located in an enclosed pump house. The charging and discharging machines each have individual hydraulic pump units located at the machines. A non-inflammable hydraulic fluid is used in all the hydraulic systems

The furnace was placed in operation in January 1953. As could be expected with the complex control system, difficulties were experienced with both the hydraulic and electrical components. However, after these troubles were worked out, the furnace has performed very well.

One change in the car moving system will be made in the near future. This has been brought about by the difficulty encountered in obtaining and maintaining a uniform speed of the furnace train, especially at very low rates of speed.

The hydraulic main furnace pusher will be removed and the train will be driven by two pneumatic tired wheels which will bear on traction plates attached to the bottom of the cars. It has been found that a force of 2000 lb is all that is required to move the train. With this small force a friction drive has been considered practical. The traction wheels will be driven by an adjustable speed d-c motor which will make it easy to control the furnace speed.

Figure 8 — Typical cross section through tunnel type annealing furnace.



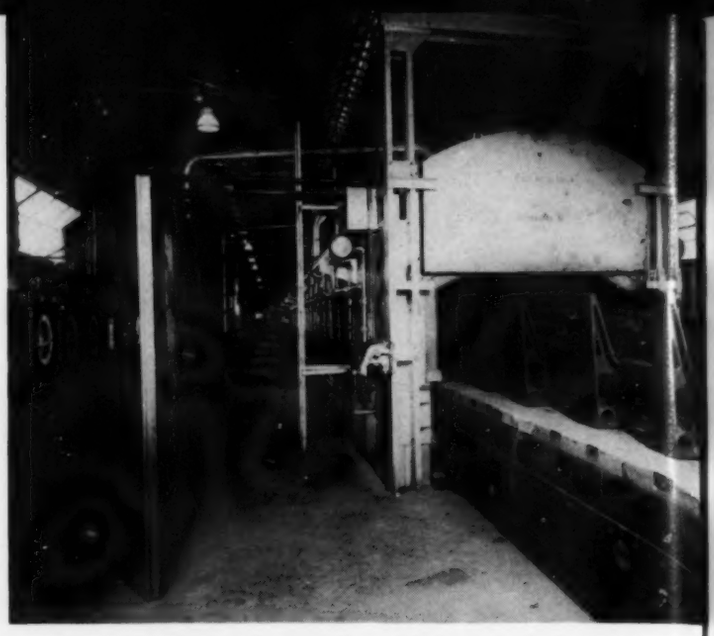


Figure 9 — Tunnel type annealing furnace shows view of discharge end.

SUMMARY

The furnace has supplied the mill with heated billets for about a year and a half. Labor costs have been reduced by the elimination of the roll down crew. Billet heating has been excellent and scale losses have been cut. It is possible to repair the furnace hearth without shutting down the furnace by working on one car at a time. This modification in the design of the tunnel type furnace has proven successful for steel mill use.

TUNNEL TYPE ANNEALING FURNACE

As mentioned previously, our company used the facilities of a ceramic producer for the annealing of billets, bars, and tubing to supplement furnace capacity in the plant. With the termination of the Korean hostilities, the demand for annealing still continued high so it was decided to install facilities in the plant to handle this work. Since the tunnel kiln had done such a good job, it was decided to build a furnace of this general type for the annealing work.

The new tunnel type annealing furnace is designed to anneal billets, bars, and tubes of various diameters and lengths at the rate of about five tons per hour.

The total time in the furnace is about 24 hours, though this can be varied to suit the annealing cycle. Steel is loaded on the cars so that there is about 1400 lb of steel per foot of furnace. The rate of travel is about 7 ft-4 in. per hour.

The furnace itself is a refractory tunnel 175 ft long by 6 ft-8 in. wide inside the brickwork. The walls are 13½ in. thick of which 4½ in. is insulation in the heating zone. Figure 8 shows a typical cross section of the furnace.

The furnace is divided into seven zones of control. Low curtain walls are provided between each zone in the form of rib arches placed under the roof arch. Flues are provided on each side of the furnace on about 4-ft centers. Burners firing top and bottom are also located on each side of the furnace. Figure 9 shows a view of the furnace from the discharging end.

The furnace cars are 6 ft-8 in. wide by 8 ft-2 in. long.

Figure 10 — To accommodate fork trucks, the furnace is housed in a building in the form of an elongated "H."

To prevent infiltration of air, the escape of gas, and to protect the running gear of the cars, the openings between the edge of the cars and the wall are protected by rib extending out over the car deck and by sand seals along the sides of the furnace. The joints between cars are sealed with a labyrinth formed by the refractory shapes on the ends of the cars.

The cars are carried by four wheels which run on railroad rails and turn on tapered roller bearings. Cradles of heat resisting alloy castings are placed on the cars to hold the steel being annealed. Since the steel may be of such a length that it will lay on several cars, couplings are provided to latch the cars together. This is done to prevent the cars from being separated in the furnace by expansion of the steel resting on them.

There are 22 furnace cars in the furnace proper. In addition there are six cars outside the furnace on the charging end and six cars on the discharging end. The train is moved through the furnace by a hydraulic under car pusher cylinder which is supplied by a variable displacement pump.

The material handling methods used with this furnace are very interesting. Since no suitable space was available inside existing plant buildings, it was decided to locate the furnace in a new building located adjacent to the outdoor storage yard where in process billets and tubes are stored. Since the stock had to be brought to this area for storage, locating the furnace away from the main plant is an advantage rather than a disadvantage as less additional stock movement is required. Material is brought adjacent to the furnace site by straddle truck.

Due to the successful results in handling steel both indoors and out with fork trucks, it was decided to use this type of equipment for loading and unloading the furnace cars. Since the fork truck would be at the furnace for handling steel, it was also decided to use the truck to return the furnace cars from the discharge to the charging end of the furnace.

To accommodate the fork truck, the furnace is housed in a pre-fabricated building of light construction in the form of an elongated "H," Figure 10. There is no crane in the building. The furnace occupies the cross bar of the "H," and the charging and discharging tracks extend out into the vertical legs of the "H." Both the charging and discharging buildings are open on one end for ready access by the fork truck.

Steel in bundles is picked up by the fork truck from bolsters in the yard adjacent to the furnace. It is brought into the charging building where the regular bundling chains are removed and 16-25-6 alloy steel chains used to withstand the furnace heat are put on. The steel is then loaded on the furnace cars which are ahead of the furnace. The steel bundles are lifted one at a time by hooks attached to a spreader bar which is attached to the forks of the truck. The steel is charged onto the cars without regard to the separation between the cars. This makes it possible to have the least possible space between ends of bundles.

The steel is removed from the furnace cars at the discharge end in the same manner it was loaded on at the charging end, Figure 11. The 16-25-6 chains are removed and the regular bundling chains are replaced. The steel is then loaded on bolsters outside the discharge building by the fork truck. The annealed steel

Figure 11 — Steel is unloaded from furnace car with fork truck.

Figure 12 — Fork truck is shown picking up furnace car for movement to charging end.

is then ready for moving by straddle truck back to the main plant for further processing.

A concrete roadway has been built to connect the charging and discharging ends of the furnace building for use by the fork truck in handling the furnace cars and picking up steel. Figure 12 shows how the cars are handled by the truck. So that there will be no delays of the fork truck by snow, this roadway is equipped with a snow melting system. Pipes are embedded in the concrete through which is circulated a heated solution of water and anti-freeze.

The heat for the snow melting system is provided by pulling the hot gases off of 8 flues on each side of the furnace and drawing them through two old boilers which have been converted to heat exchangers. The solution is pumped through the heat exchangers and pavement coils.

This furnace was put into operation in October 1954. Very little difficulty was experienced in getting it into operation. The results have been excellent. The tunnel type furnace has proved its adaptability to steel mill use in this case. By using the material handling advantages, which are inherent with this type of furnace, handling costs have been kept to a minimum.

PART II

HEATING AND COMBUSTION FEATURES

By D. R. BAKER

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▲ EVEN though these two continuous car type tunnel furnaces could have come equipped with gold-plated hub caps, the proof of the pudding is the "heating." And ever since the first tunnel type furnace was developed for the ceramic industry, besides the great labor saving advantage over the periodic kiln type, the fuel savings advantage, as well as better uniformity of heating, has been recognized as the chief advantages. Likewise, in the metallurgical industry, the use of the counterflow theory of the work moving opposite the flow of gases, utilizes the waste heat to preheat the incoming material. It is obvious that a continuous furnace operated at more or less constant temperatures should be more efficient than batch type furnaces where heat must be put into the furnace structure; then removed to accommodate loading and unloading or heating cycles. Also, the loads are small compared to the batch type furnaces so that there is very good heat distribution and uniformity.

A big advantage of the straight-a-way tunnel furnace over the rotary or circular type is that the shape and length of the billets, bar, or tubing conforms to the hearth much better, and there is no pile-shaped loading as the spokes of a wheel. Probably the biggest advantage of the straight vs the rotary type is the availability of any portion of the hearth for repair without emergency shutdowns and delay to production. However, the value of this advantage is somewhat lessened by the loss of heat and thermal shock of the refractories by exposing the hearth to atmospheric conditions during the changing of cars.

TUNNEL TYPE FOR BILLET HEATING AT NO. 2 TUBE MILL

As was stated in Mr. Cook's paper, this furnace replaced a rolldown furnace which had a hearth area of 1,027 sq ft and combustion volume of 3,220 cu ft. It was two zone (preheat and soak) both top-fired with a maximum input of 35,000 cfhr of natural gas at 1,050 Btu per cu ft and rated capacity of 20 tons per hr.

The new car type furnace has a hearth area of 1,242 sq ft and 4,692 cu ft combustion volume in the heating space with a rated capacity of 40 tons per hr on the largest billet. It has a burner capacity of 148,000 cfhr natural gas. Comparing this to the first large rotary type furnace that was built in this country for heating billets at our No. 3 piercing mill, this straight tunnel type has less than one-half the hearth area and less than one-fourth the combustion volume in the heating area with practically the same tonnage rating. This low combustion space was requested in the design to reduce heat loss through the walls, better heat transfer and less maintenance resulting from lower side walls.

This new furnace has technically five chambers, all separated by hanging refractory baffle walls. See Figure 2 of Mr. Cook's paper. The first chamber, as a car is moved off the elevator at the charging end, is used to: (1) restore the heat lost in the car refractory, and (2) to preheat and dry out newly constructed car decks. This zone is equipped with two manually controlled burners with temperature indication, and present practice is to operate at 1200 to 1500 F. Caution must be taken to prevent too much heat reaching the steel top of elevators and limit switches before another car contacts the train.

In the next zone, the cars are charged in a 2 ft-6 in. space where there is no heating and the charging door is usually open. The billets are charged in double row where length permits; and into a single row above 64 in. length. The steel then passes under a 3 ft wide baffle built within 10 in. above the car deck. This must be as close as possible to permit the largest diameter billet to pass under and still prevent excessive leakage or short circuiting of the stack flue which takes off immediately on downstream side of this baffle wall.

The steel then enters zone 1 of the heating cycle. This zone is equipped with 12 burners, six of which are nozzle mix or short flame to prevent carryout of flame into exhaust flue. The other six are luminous flame type and are located three feet above the steel and one foot below the flat roof. Temperature is controlled in this zone from a platinum-platinum rhodium thermocouple located one foot above the hearth on the sidewall as the steel enters the last one-third of the zone. This zone is 45 feet long. Present practice is to use these

burners as little as possible and usually have the control temperature set 300 to 500 F below final temperature. The heaters have the optional use of this zone depending on the fuel rate of No. 2 zone.

The steel then passes into No. 2 zone which is used as the "work horse" of the furnace and has an input of 50,000 cfhr through 12 luminous flame burners spaced 5-ft on centers. These burners are located at the same elevation as in No. 1 zone and fire directly into the burner on the opposite side with six on each side. Firing into each other rather than staggering has aided heating in the center of the billets where under-the-billet circulation of hot gases is difficult to maintain.

This zone is controlled by a platinum-platinum rhodium couple located approximately two-thirds down the zone as the steel travels toward the discharge end, and the temperature setting is usually 50 to 100 F below final temperature. However, at maximum speed and single row of billets, which means only ⅔ to ¾ of the hearth covered, it is necessary to carry this zone the same as the final temperature setting.

After the steel travels the 30 feet in zone No. 2, it enters the final soak zone which is 28 ft-5 in. to the discharge position. This space is equipped with ten luminous flame burners, the same spacing as zone No. 2 plus one additional burner opposite the discharge door. The ten burners are controlled from an average temperature of two or individual radiation pyrometers on each side of furnace located approximately in center of zone and just above the largest billet. The single burner is manually controlled to take care of heat losses while discharge door is open and under the baffle at discharge end.

The furnace pressure is automatically controlled from a furnace tap approximately 10 ft from discharge door near hearth level. This differential pressure on a diaphragm operates a jet pipe regulator which hydraulically operates a 5 x 30-in. cylinder which moves a counterweighted damper up or down in the 5-ft underground flue at the base of the stack. The hydraulic furnace pressure controllers, as well as the fuel-air ratio units, use non-flammable fluid, the same as used in large hydraulic units.

The control instruments are located in a pressurized room and consist of the following: three circular chart 1000 to 2500 F electronic recording controllers, three fuel-air indicators, one 8-point electronic strip chart temperature recorder, one furnace pressure recorder, one total gas flow meter, one total oil flow meter, three fuel-air ratio hydraulic regulators, one furnace pressure regulator, two pump and tank units and various safety switches.

The temperature controllers for each zone operate by air pressure, a valve positioner on the gas adjustable port valve, or oil constant flow valve. Then from orifice measurements, the hydraulic unit positions a crank arm cylinder on the air butterfly valve maintaining correct or desired fuel-air ratio. There was some concern about insufficient orifice runs for the air measurement, necessitating the installation of the orifice on the suction side of fans. However, this has proven very satisfactory and furnace atmosphere has checked very closely on the heat prover to ratio setting. It has been the practice to operate with 5 to 15 per cent excess air depending on best heating rate for the particular size and type of billet.

There is a complete stand-by heavy oil system and oil burners on this furnace. A circulating pump circulates oil from the plant lines around the furnace during expected gas curtailment periods. Then it is dead ended and forced through synchro-pneumatic constant flow valves and oil-steam ratio regulator on each zone. The oil and steam then travels through individual lines to the combination burners where the oil is atomized and burned. The short period of firing with oil has indicated this system is very easily put into service and heating conditions are as good if not better than with natural gas.

There is a safety shutoff valve on the main gas line and main oil line that is interlocked with the three main combustion air blowers, the control oil pressure, the control air pressure, gas pressure and/or steam and oil pressure.

RESULTS

From the time the first billet went through this furnace to the present there have been no serious problems with the quality of heating as to uniformity. With large orders, 40 tons per hour can be heated at a fuel consumption of approximately 2,500,000 Btu per ton. However, on the small orders and below 10 tons per hour, further effort must be made to improve the fuel rate.

The scale condition is improved over the rolldown furnace and is now a thin tight scale that is desired. Also, there are no longer patches that are knocked off in the furnace with later reformed scale before the billet is discharged.

There are over 65 compositions of steel heated to final temperatures from 1825 F to 2275 F beside the wide range of diameters and lengths along with many short orders as low as ten pieces which necessitates heating changes be made quickly and with minimum effort.

Non-uniform heating is very quickly determined from the close tolerances on concentricity of the pierced seamless tubing required for making tapered roller bearings.

TUNNEL TYPE ANNEALING FURNACE

Even though there was seemingly ten years experience annealing steel in make-shift kilns at tile plants, there was much to be desired should the opportunity arise to design a new straight continuous car type furnace. The comparatively good results were obtained by one or two plant personnel who constantly adjusted burners and air flow to strive to approach the cycle desired by our metallurgists. Also temporary plant arrangement required a large number of men for the bar and tubing handling. So, the number one requirement was a fully automatically controlled heating with the minimum of labor which now consists of a heater and a fork truck operator on each turn.

In the design of the annealing furnace (Figure 9, Mr. Cook's paper), the width and height of the furnace was adopted from 8-batch car type annealing furnaces

which have stainless steel bucks or cradles to support the load 13½ in. above the car deck to create flues for under-firing. These same bucks are used on the car decks of the new tunnel furnace, and structurally, they have held up well during repeated cycles on the batch car type. They have proven their value over brick piers by practically no maintenance even after three or four years of service in the batch car type furnaces.

The length of the furnace was determined from the longest of four annealing cycles which were to be run in this furnace. This most critical cycle is used to obtain certain structure and is essentially rapid heating to 1600 F, soak for uniformity, fast cool to 1375 F, then slow cool 20 F per hour to 1100 F where the steel can be air quenched or discharged.

The next and most important phase of design of this furnace was uniformity of temperature throughout the load where ±10 F makes a difference in quality tubing. In a continuous roller hearth this phase is important even on a single layer of tubing or bar stock. Also in batch car and hood type furnaces, uniformity of heat distribution is very important, but in these furnaces the cycle can be held at any point until any one of numerous check thermocouples come into the narrow standards of maximum variations.

This continuous tunnel type is somewhat between the roller hearth furnaces and the batch car and hood type on unloading. And even though effort is made to load the cars uniformly, the nature of orders and urgency of shipment makes this almost impossible. The load varies from thin wall tubing to extremely heavy wall, and many orders of solid bars up to 10 in. in diameter. Likewise, the tonnage varies from three to six tons per car. Also, sufficient capacity for heating and cooling had to be incorporated in the furnace for changing cycles with minimum loss of time and tonnage.

In the heating zone, it was fairly easy to calculate the heat input necessary under maximum load conditions, and the soak zone was a fairly standard furnace problem. However, the fast cool and subsequent slow cool brought in many different designs from furnace builders.

Initial calculations indicated natural flow of heat through a 9-in. hard firebrick wall and crown would extract sufficient heat to provide the desired cooling rate. However, with this method, besides being uncontrollable automatically, it was impossible to predict the temperature gradient from outside to center of bundle or load with line contact of the tubing with various wall thicknesses. Other methods of using recirculated air with manual and automatic adjustment of blending external air were proposed. The ceramic continuous kilns use panel cooling with cold air wiping the back side of thin silicon carbide slabs along with direct fan cooling, tempered with various amounts of recirculated air. This can be admitted through crown blasts at different amounts in the cooling section. These methods seemed to have too many necessary manual adjustments to provide the flexibility desired in this furnace.

It was then decided to divide the cooling section into a fast cool zone, a soak zone or levelling off zone, and three slow cool zones which made a total of seven zones with the heating; then design the furnace the same as seven car type furnaces fastened together on the ends. By the use of tempered flame or tempered air through burners and maintaining positive furnace pressure by constant air, very close uniformity has been obtained with larger loads in the batch car type furnace. This modified convection heating was made possible by the development of the tempered flame burners which stay lit with high excess air and were first applied on annealing furnaces at the plant in 1945.

The burners (Figure 8, Mr. Cook's paper) are all the same size, i.e. 300 cfhr of natural gas, and are spaced 4-ft on centers on the top row, staggered with burners on the bottom on the same centers. This is on both sides for a total of 172 burners. Thus, the load is receiving heat at every 2-ft travel, alternately on the top or bottom. The number burners and 4½ x 9 in. exhaust flues are given in Table I.

TABLE I

Zone	Burners	Flues	Portion of 24-hr cycle
1	36	9	5 hours heating
2	22	7	3 hours soak
3	14	5	2 hours fast cool
4	20	6	2½ hours soak or slow cool
5	28	8	11½ hours slow cool
6	28	8	
7	24	8	

The flues have their openings just above hearth level and are adjusted by restricting the top of flues to give slightly positive pressure at hearth.

Temperature is controlled in each zone by one electronic recording controller using a chromel-alumel thermocouple placed approximately 3-ft from end of zone. Thus, there are seven controllers, relays, and motorized adjustable port gas valves. Also, there is a twelve-point strip chart recorder that was used to check 12 additional points in the furnace. However, since running repeated tests with traveling thermocouples in the load, it was decided to use the recorder to record only the seven control couples which adequately indicate furnace conditions.

The temperature controllers are fully proportioning with automatic reset and they control the valves in fuel line to each zone. The air is adjusted manually by butterfly valves at the fans and once adjusted is seldom altered. Sufficient air is admitted in the cooling zones to obtain the desired cooling rate and still call for a little heating in order to obtain the well tempered air. The thermocouples are 5-ft long and hang down through the arched roof. There are also arms and linkage such that they can be raised or lowered from floor level to obtain furnace temperature readings close to the top of load. However, from the present operating experience of uniformity in furnace, it has not been necessary to raise and lower the thermocouples.

In addition to temperature control instruments, there are flow gages on gas and air lines to each zone. There is also a furnace pressure recorder and totalizing gas meter. Propane is used as stand-by fuel with no special equipment needed for control.

For safety and to prevent light-up explosions, the furnace is equipped with a supervisory system consisting of an individual pilot for each gas burner and a side ported shutoff cock in gas line to each main burner. Then there is a main safety shutoff valve in main gas line that is actuated from pilotstats or air pressure switches on each of five combustion air blowers where electric or blower failure on any one blower will close the main gas line. Every burner gas cock must be in the closed position before the pilot line can be charged with gas. Then the pilots should be lit before the main safety valve is opened. The main weakness of this safety system is the lack of assurance that all of the 172 pilots have been ignited before proceeding to turn on main burners. It still is necessary to depend on an individual to follow correct light-up procedure. The pilot burners and pilot premixers have been remarkably dependable; and once adjusted properly, there has not been a single failure in the four months of operation.

The scale condition of the steel from this furnace is reported as better than from the batch car type furnaces. That is, it is easier removed in pickle operations. This may be due to shorter time coming to heat due to reduced load.

The other results for quality on structure and for tonnage have been satisfactory to the present. The furnace has averaged over four tons per hour as a monthly average with a fuel consumption of 9,000 to 11,000 cfhr of natural gas at 1050 Btu per cu ft. The addition of this furnace has supplemented tonnage capacity equivalent to at least four large batch car type furnaces. It is also very flexible for extra long lengths and for various annealing cycles. It is adaptable for full annealing by either slow cool method through the transformation range or isothermal method to produce controlled pearlitic microstructures ranging from 100 per cent spheroidized to 100 per cent lamellar structure. It can also be used as subcritical or tempering, sometimes referred to as process annealing.

DISCUSSION

PRESENTED BY

JAMES E. HOVIS, Sales Engineer, Furnace Division, Gas Machinery Co., Cleveland, Ohio.

D. R. BAKER, Combustion Engineer, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio.

ADIN B. CAPRON, Chief Engineer, Babcock and Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

J. T. COOK, Assistant Chief Engineer, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio.

N. LOUIS SHAGALOFF, Design Engineer, Swindell Dressler Corp., Pittsburgh, Pa.

James Hovis: With respect to the heating furnace, one question I have is: With the sand seal arrangement you have on a rather long furnace, we wonder if you might not give us your experience; that is, what your maintenance picture is after this period of operation and whether it does constitute a problem in maintaining the sand seal.

The other question is rather academic, but I think in the light of your operating experience to date that you may be able to give us some interesting information which relates to the tonnage which the heating furnace was designed for versus the furnace length.

Naturally, if you make the furnace fifty per cent longer, you can run a colder charging zone and drop the fuel figure down. There are a lot of other factors involved. However, in the light of your experience, you may be able to indicate whether you think it advisable to go to a little longer furnace, to drop the fuel figure or whether other factors preclude this possibility. On the annealing furnace, you pointed out one advantage over the roller hearth, and that is the ability to stop and correct a cycle condition.

I was wondering what your experience is relative to material handling costs as compared to roller hearth furnace. You do have to return the cars. Do you have the figures on hand for handling cost per ton?

D. R. Baker: With regard to the sand seals, it is true that there has been considerable maintenance, that is, broken car refractories getting down into the sand seals, thus clogging the discharge chutes. However, most of the difficulty has been at the discharge end, but that is readily accessible by taking out one car and reaching this point of difficulty on week-ends. So far, we have been on fifteen-turn operations. We had an automatic sand return system on this, which would automatically return the sand to the charge end. However, the automatic portion of the equipment was discarded fairly early. Air pressure is applied periodically to the sand receiving bin and returned through piping to the bin at the charging end of furnace.

As to the longer length, it certainly is desirable to have a longer length to utilize more the waste gas temperature.

However, where space and money is limited, it was not possible in this case and at our tonnage rates where we are running the furnace at capacity, we feel that we are reaching a fuel consumption that is fairly comparable to the rotary hearth furnace. Of course, there are some changes that could be made in a rotary furnace that would better the fuel consumption also. I think the use of recuperators and preheated air would probably be the most advantageous, either on this furnace or on the rotary furnace.

The other question was on the comparative material handling cost on the tunnel anneal furnace vs a roller furnace. I am sorry I have no figures on that at all.

Adin B. Capron: All of us in the industry have been very interested in this development on the use of a tunnel furnace. We use them, of course, in our refractories division and have thought of it for billet heating also, but in our case, we just did not have the proper shape area to use it.

I do have some things to ask Mr. Cook. You did not go into detail on the design of the cars, but I assume you use refractory tops. How have these tops stood up in service to date? Also, have you used ordinary brick tops or are they of some special material?

On the annealing furnace, I see that you had doors on the end, but I also understood that you did not make the movements in complete car lengths. Does that mean that the doors stay open all the time and that you cannot close them?

J. T. Cook: I shall answer the second part of your question first. The doors on the tunnel type annealing furnace do stay open continuously. They were put on primarily so the furnace could be closed up for the purpose of getting up to heat faster when starting up. During the regular operations, however, the doors are open all the time and the cars move continuously. There is, however, a brief pause while the pusher cylinder returns to its starting position, but outside of that, the cars move continuously.

In answer to the question about the cars in the tunnel type billet heating furnace, I believe that can best be covered by a brief history of the types of construction used for the car decks.

We started out with the decks built up out of fire brick and special shapes. These did not hold up as well as we felt they should. In all fairness, it should be pointed out that a part of the trouble might have been due to the mechanical abuse to which the cars were subjected in the initial phases of starting up the furnace. This abuse was caused by malfunction of the rather complicated control equipment in the early days of operation, which allowed the cars to bump into each other at high speeds.

The next stage of car deck construction was the use of a castable deck. The large special refractory shapes around the edge of the deck were retained, but the deck proper was castable, without any refractory rails. The billets were laid directly on the flat deck.

A further stage in the development of the car deck was the use of refractory rails in the castable deck to raise the bottom of the billets above the deck to improve their heating characteristics.

The special castable shapes around the edge of the cars had a tendency to break off from time to time, especially at the corners and ends of the cars. Breakage on the sides sometimes caused jams in the sand seals; and breakage on the ends left pockets into which the billets would roll, making it difficult for the discharge machine to pick them up.

In order to eliminate the rebuilds caused by the breakage of the shapes on the sides of the cars, these tile were replaced by alloy castings. The results were so promising that it was also decided to replace the special tile on the ends of the cars with alloy castings.

At the present time, our cars have alloy castings forming a curb completely around the car on both sides and ends up to the top of the deck. These castings are formed to give the same general shape as the original tile, thus forming the overhangs necessary to protect the under part of the car from direct radiation from the furnace chamber. The deck itself is made up of a castable material with suitable expansion joints provided. Special fire brick shapes with serrated tops are used to form the rails on which the billets are placed. This type of construction appears to be giving satisfactory service.

Member: Have you had any problem with the under car structure, as far as the temperature, or are your tapered roller bearings sufficient for that problem?

Admittedly, ceramic kilns are operated at 500 to 1,000 F higher temperature than these applications, but one of the problems that has existed is getting sufficient air on the under car structure. This has been handled by temperature regulating control, which regulated the amount of circulating air which is often assisted by a different pressure measurement.

Have you had any problems underneath? And the other passing through in the extension of these systems, which has been described here for Timken is also similar to Armco at Ashland, is to use, since you are using pusher mechanism, a recording pressure gage with signal contact. This has been used to determine potential difficulties in the track system which might precede any wrecks. That has paid off very well in the ceramic industry.

D. R. Baker: With regard to the temperature underneath the car wheels or on the car moving mechanism on this billet heating furnace, we ran repeated checks on the bearings and the maximum temperature that we could obtain with a touch-thermocouple was about 150 F.

We have good air circulation and we feel that a rubber tire will work on a friction plate, and it was on that basis that we have decided to go to a mechanical drive.

Member: Even with your pipe coolers underneath, I thought you would get higher than that. It must be putting through quite a bit of air.

D. R. Baker: With regard to the pressure measuring gage on the pushing mechanism, we have not installed that on our billet heating furnace because there has been no indication that there has been any wreck or any damage or any resistance to movement.

The maximum pressure of only 2,000 lb thrust starts the complete train through the billet heating furnace. On the anneal furnace, we are at the present time installing a hydraulic pressure gage, not for the purpose of determining car wrecks, but more for the purpose of determining regularity of car pushing and recording time of car movements.

N. Louis Shagaloff: Having designed many tunnel type furnaces for the ceramic industry, and now having had the experience of designing the billet heating furnace for Timken, we have heard these papers as an interesting comparison between the long-accepted use of tunnel type furnaces in handling ceramic ware, and this newer application to serve the steel industry. It might be interesting to discuss a little further one essential difference between these two applications of the tunnel type furnace. For ceramic ware, the ware itself must go through a cooling zone before it leaves the furnace. This automatically puts the car refractories through a cooling cycle so that the thermal shock to the car refractories, when leaving the furnace, is reduced to a minimum. For the billet heating furnace, this advantage cannot be utilized since the billets have to be at maximum temperature when leaving the furnace. Obviously, it would be impractical to carry empty cars through a cooling zone, or to take cars directly from a condition of maximum tempera-

ture to room temperature. The return of the cars through a tunnel seems to be a practical solution of the problem. Although the tunnel is not heated, it is built to comparatively close clearances around the car so as to prevent large losses of temperature. Also, the movement through the tunnel is fast.

Mr. Cook stated that it requires about four minutes to move a car from its position at the forward end of the train back into position at the rear of the train at the charging end. I hope Mr. Cook will not mind it if I make a correction on this point. The movements of the cars were based on a 265-second cycle with the train moving at its maximum allowable speed. That is, a car enters the furnace every four and one-third minutes. Of these 265 seconds, only about 101 seconds are consumed from the time a car is moved away from the leading end of the train, until that car is back on the entrance elevator at furnace level ready to be again moved into the furnace. The thinking was, of course, to get the car through the tunnel at the fastest practical speed.

Mr. Cook mentioned that the movements of the train, and return of the cars is automatic. In this connection, we might mention three provisions in this automatic cycling.

1. To take full advantage of the feature of returning empty cars through the tunnel, the time required for this return trip is the same for each car, regardless of how fast the train is moving.

2. For the same reason, once a car has started a return trip, it will complete that trip even though, in the meantime, the train has been stopped.

3. As has been said, the train can be stopped at any point; also, certain elements, such as the elevators, can be taken off of automatic and put on manual control. After any such interruption of automatic cycling, the controls will take over on "automatic" at whatever point in the cycle has then been reached. In other words, after a stop, or a period of manual control, the operator needs only to put all controls back on "automatic" without having to check the positions of the various components. And, of course, the controls were designed to make any failure a "fail-safe" one.

Again, as designers of tunnel type furnaces for both the ceramic and steel industries, we could not help but notice the difference between the fuel consumption for the two furnaces described in these papers. Mr. Baker's figures indicate a heat input of 2,500,000 Btu per ton for the billet heating furnace taking the load up to about 2300 F, and about 2,900,000 Btu per ton for the annealing furnace taking the load up to only 1600 F. The ceramic industry is more sensitive about excessive use of fuel than is the steel industry, so that we have learned to control the cooling rate from large masses of ceramic ware without the addition of more heat in the cooling zone. We realize, of course, that other factors enter into this problem in addition to that of fuel economy.

These papers indicate that there definitely is a place in the steel industry for the tunnel type furnace.

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Used in Rolling Mills

▲ COMPOSITION bearings, sometimes referred to as phenolic resin, fabric, or plastic bearings, have been very successful particularly as a roll-neck bearing in many steel mills. With copious amounts of water being applied to steel rolling mills for cooling purposes, the advent of composition bearings which required only water as a lubricant became a bearing material worthy of experimentation.

It is reputed that this type of bearing originated when a mill operator needed a bearing replacement to complete a production run and improvised a bearing surface by cutting several pieces of rags, soaking them in oil, and then placed piece upon piece to obtain the proper bearing thickness under the roll-necks. With this bearing, he completed the turn with little difficulty and eventually patented the idea. In the early 1930's, the laminated fabric industry acquired the idea and replaced the oil with phenolic resins and the carrying medium became various weights of cotton duck, belting and other fabrics to form the present composition bearing.

Of the numerous fabrics available two are now in general use: A relatively fine weave cotton duck weighing about 10 to 15 oz per sq yd and a single ply woven cotton cord duck weighing from 20 to 30 oz per sq yd. These fabrics are impregnated with phenol-type synthetic resins until they contain about half their weight of solid resin. This impregnated material is laminated to the required thickness and then molded under one to two tons per sq in. pressure, at temperatures up to 350 F for one hour per in. of thickness, and cooled to workable temperatures while still under pressure. To meet the variety of conditions experienced in the rolling mills, various resins are used in combinations with different weights of fabrics. From these variants come the different composition bearing formulations available in the industry, each having its strong characteristics for various applications.

The principal properties of these materials to be considered for bearing design are impact strength, compressive strength, absorption and expansion when in contact with fluid lubricants, thermal expansion, thermal conductivity, resistance to corrosion, coefficient of friction, rate of wear, and resilience under bearing pressure. These properties will be considered for the commonly used types of laminated composition bearings.

The impact strength is measured perpendicular to the laminations and show values from 10 to 14 ft lb per sq in., depending on duck material. This property indicates the laminates' ability to resist cracking from the direct effects of impact from the journal. According to ASTM test methods, compressive strength of these materials averages about 40,000 psi in the direction perpendicular to the laminations.

The important strength factor in bearing design is a combination of static and dynamic loading-compressive and impact strengths. Therefore, the theoretical strength must be reduced by practical considerations such as rubbing speed, amount and type of lubrication, clearances and type of loading. In practice, it has been found that these composition bearings are successful for loads up to 6,000 psi. Above this value, high friction losses and cold flow of the laminate limit the efficiency of the bearing.

These bearings always expand to some extent when in contact with a fluid lubricant or atmospheric moisture, because of absorption which at saturation point runs around 0.025 in. per in. of thickness and 0.005 on width and length. This must be compensated for in design by providing space in every direction except in the backing surfaces of the bearing, which should be of solid construction and retain original dimensions.

Running clearances for composition bearings are generally of the same order as those used for metallic bearings with similar lubricants, pressure and speed except that absorption expansion must be added to the running clearance to obtain satisfactory design. Thermal expansion of composition bearings is so small that it need not be considered in the design. However, since it is low, the difference between the expansion of the composition and metallic parts in contact with it, may cause distortion when the parts are at widely different temperatures.

Composition bearings are poor heat conductors, the conductivity value being only 2.5 Btu per sq ft per degree F per in. Therefore, heat generated or transmitted to the journal must be carried away through the lubricant to prevent a dangerous temperature rise. Consideration of conductivity is one of the most im-

Properly designed and lubricated composition bearings have many possibilities for rolling mill usage . . . . cool, neutral, clean water should be available preferably on separate bearing system . . . . journals and necks must be smooth, rust and crack free . . . . surface speeds should be 200 rpm and continuous.

portant factors in composition bearing design, since the accumulation of heat in the journal is rapid and can quickly reach the charring temperature of the laminated plastic.

The resistance of composition bearings to chemicals varies somewhat for the different grades, although most are easily destroyed by hot strong alkaline solutions and mild acid solutions. However, most hydrocarbon solvents and lubricants do not attack them to any appreciable extent.

This material has wonderful resiliency, higher than most metallic materials. Composition bearings have a resiliency of 0.002 in. per 1000 psi per in. thickness. This means that the bearing should not be more than ½ in. thick for every 1000 psi per 0.001 in. allowable "spring." Expected deflection in the bearing blocks and the mill housing should be added in determining the total "spring." For this reason, these bearings cushion shock transmission between roll and housing, and can be designed for much higher loading than metallic bearings.

The coefficient of friction of composition bearings varies considerably from a high figure at slow speeds and heavy loads to a very low figure with high speeds and light loads. When operating at low rubbing speeds, below 200 fpm, grease or oil lubrication should be used in conjunction with water for cooling. However, at higher speeds, water lubrication is usually sufficient and generally offers the lowest friction losses. These low friction losses often mean considerable saving in power necessary to drive many mills converted over from metallic type bearings.

In order to operate composition roll neck bearings at their highest efficiency, clean, cool water, free from abrasives must be supplied for both cooling and lubrication. This water must be applied correctly and in sufficient quantity, the volume being more important than the pressure. A general rule for calculating the quantity of water required for composition bearings in gallons per min (gpm) may be taken as equal to:

$$\text{Gpm} = \frac{(D \times W \times F \times \text{rpm})}{8000}$$

Where D=diameter of roll neck in in.
W=total load in bearing in lb
F=coefficient of friction—normally 0.004 to 0.008

In addition, roll necks should be smooth and either swabbed or sprayed with mineral oil during shutdown periods to prevent the formation of rust on the necks and thereby minimize the rate of bearing wear. Some mills have automatic spray units which inject emulsifying oil solution on the roll necks at the time of shutdown and also before starting up.

The water temperature is important to successful operation of these bearings. In general, the lower the water temperature, the better. However, it should be kept in mind that when the water is warmer, more care has to be exercised in its application and usually a greater volume is needed to keep the journals cool. In any event, the water temperature should not exceed 135 F for steel mill roll neck bearing service. Above this temperature, the viscosity of water is so low that unless loads are very light, contact between journal and bearing will be made, and hot spots may cause delamination of the fabric.

In all composition bearing applications, it is essential to have water inserted into the bearing chucks for lubrication and cooling of the composition bearings and journal, both for the radial and the thrust areas. This is accomplished by inserting pipes into the chucks. The load zone on composition bearings averages about 130 F; the carrier bearing for the top roll is always of shorter arc length. Therefore, there is a space available between these bearings for insertion of a water pipe. These pipes are drilled with a series of small holes along their length so that water can impinge on the roll neck. Sometimes nozzles are used instead of just small holes to give a fan action. The rotation of the necks of the rolls tends to pull the water right into the fabric bearing load zone. This radial bearing is always made with a long bevel on the neck side to provide easy access of water into it. Water must also play onto the thrust collar area.

A suggested practice for thrust collars is to make wedge cuts in the face of the collar. The cut should be ⅜ in. wide by ⅜ in. deep at the top, tapering and narrowing to nothing at the bottom. The size and number of cuts used is dependent upon the size of the collar. In an extreme pressure situation, these cuts can be grease lubricated. This procedure also reduces initial torque in starting the mill or reversing it.

Water pressure should be governed by the consideration that turbulence or splash must be avoided as much as possible since they hinder the cooling and lubricating effect of the water. By making the holes in spray pipes large enough, the water will flow onto the neck without bouncing off. Open-end pipes, hoses, and petcocks with just enough pressure to spread the water over the surface will likewise give excellent results. One good rule to remember in lubricating composition bearings is to put the water on, so that it stays on the exposed surface of the journal as long as possible.

For slow or average-speed rolling mills, place the water pipe on the outcoming side of the bearing so that water stays on the exposed revolving surface throughout its travel back into the bearing. In this way, the water cools the journal for the longest period before acting as a lubricant for the bearing. If one inlet pipe is not sufficient to dissipate the heat from the journal then another pipe may be placed on the inlet side of the bearing.

Where there is both a top and bottom bearing section on the same journal, two pipes should be used, one near the outlet side of the bottom bearing, and one near the outlet side of the top bearing. This keeps the exposed sections of the journal covered with water to give the greatest cooling effect.

There are of course exceptions to any general rule such as on some high speed mills, where water is sometimes placed only on the inlet side of the bearing. The explanation for this is that sufficient speed is available to draw the water through the bearing area and carry enough around the surface of the journal to keep it

cool. In addition, water-lubricated composition bearings have very low frictional values on high speed shafts.

Composition bearings are also used on reversing mills but usually in conjunction with grease which reduces the high starting torque. On these mills, the water is usually applied near the top of the exposed area of the journal on each side of the bearing area. As a rule, the speed of these mills is slow enough to allow the water to run down and cover all the exposed surface of the journal and neck. Sometimes a third pipe is added at the top of the bottom roll and bottom of top roll to add its cooling effect. This is particularly so on large plate mills where the neck diameters are 30 to 36 in.

When grease is introduced on a composition bearing, a heavily chamfered hole outside the load zone has proved effective as a means of entry. This forms a lubricant reservoir from which the grease spreads through the bearing area. On reversing mills, two such entry ports are needed, both located outside the major load area. Either soluable or non-soluable greases are being used for these high-pressure, slow-speed applications of such specification that the film will resist rupture even under maximum loads.

However, usually only about one-third of the grease used on metallic bearings is necessary to maintain adequate lubrication on these composition bearings.

One factor of extreme importance in converting a mill to fabric bearings is to make the water supply lines a separate system so that water may be shut off the mill rolls, guides, and passes while the mill is rolling (for an adjustment), without shutting water off the bearings. This will extend bearing life immensely.

When the color of the bearing and the journal is dark brown, it is an indication that satisfactory lubrication methods are being used. Light yellow, rough appearing bearing surfaces and bright or light gray journals are usually the result of rough or etched metal literally cutting or machining away the bearing. Scores or ridges in either or both the journal or bearing indicate scale or dirty water trouble and again the color of the bearing is light yellow. Fire cracked or checked roll necks also cause rapid bearing wear or cutting. Charred or burned bearings indicate lack of sufficient water. These usually are black in color and, on close examination, a smell of burned material may be detected. However, although cast iron roll journals take on a dark brown polish, some grades of cast steel rolls may always stay bright.

Recently, the composition bearing has come into its own with the contained neck design bearing, sometimes referred to as the totally enclosed fabric bearing. When composition bearings were first introduced, they replaced metallic bearings, usually in the same chuck and under the same conditions. These open check designs exposed the fabric to scale and abrasive conditions. In many instances, this prevented composition bearings from being used. Recognizing the fact that laminated fabrics are an engineering material, mill builders have developed enclosed-neck designs which are giving top performances as a bearing application.

These have three advantages over the open chuck design. (1) The neck and bearing assembly is fully contained, thereby affording positive lubrication that can be closely controlled both as to volume and pressure. (2) Mill scale and abrasives have been eliminated from the bearing area, thereby greatly diminishing one of the main causes of fabric bearing wear. (3) The enclosed neck design affords a more positive method of introducing supplementary lubrication both for difficult sections and for the "down" periods.

Fabric bearings have been used successfully on practically every type of mill. The author knows that they are being used on small and large bar mills, rod mills, structural mills, bloomers, plate mills, and some strip mills.

When properly applied, composition bearings have reduced mill delays by giving longer service life. They are very predictable as to wear life, since trouble is indicated by either a pungent smell or smoke. They have lowered power consumption, usually 20 or 25 per cent but sometimes as high as 50 per cent because of less frictional loss at the journals. They have reduced lubrication costs, because where speeds are uniformly high no lubricant is needed. Because of no grease or oil, many mills are much cleaner and easier to maintain. They have improved accuracy of section on many mills, particularly bar mills, because their resiliency and resistance to wear require less adjustment to keep section on these mills.

In conclusion, composition bearings afford many possibilities for use when properly designed, installed and lubricated. Water must be relatively cool with plently of volume available, preferably on a separate system for the bearings. The water must be free from scale and abrasives and not be acid or basic. Roll necks and journals must be smooth and free from rust or fire cracks. Surface speeds should be over 200 fpm and continuous, to use water alone. The supply of cooling water must be clean, cool, and constant.

DISCUSSION

PRESENTED BY

FRED A. HORN, General Superintendent, Hot Rolling Mills, Ford Motor Co., Rouge Plant, Dearborn, Mich.

K. E. McHENRY, Assistant to Superintendent, Mechanical Department, Bethlehem Steel Co., Lackawanna, N. Y.

Fred A. Horn: Do you have any data to compare the life or the cost of the composition bearings versus the brass and babbitt on blooming mill rollers?

In other words, we may change the brass and babbitt bearings, say, every second roll change. What could we expect from the composition bearings?

K. E. McHenry: I will be glad to answer that. However, Mr. Horn, before I could properly answer it, I would have to consider some of the conditions under which you may operate.

We have composition bearings on some of our blooming mills. However, we have omitted using them on the bottom bearings because we have not been able

to remove the scale. Now, on some of our more recent installations, we have composition bearings on both top carrier and bottom bearings because suitable scale-guards have been designed.

Now, so far as the price is concerned, I think that you would find the price of a composition bearing to be comparable with the cost of a babbitt bearing, and when properly used, I think you could expect longer life than you would get from a babbitt bearing.

When I say "properly" used, I mean it would be used, of course, with water supply and grease lubrication because of it being a reversing mill. You would be able to cut down your grease consumption some in converting from babbitt to composition.

It would be to your advantage to put a separate water supply on the roll neck to eliminate water failure. You would have to use some type of scale guard, particularly if you intended to use it on the bottom bearing. On the top and carrier bearing, you could probably put fabric bearings in there without any other changes from the use of babbitt.

Fred A. Horn: How much longer life could we expect from composition bearings over brass and babbitt?

K. E. McHenry: That would depend on the condition of your roll neck and the number of times you are changing rolls. It has been our experience that in all of our blooming mills, we have had longer bearing life with fabric than we have had with babbitt, except on bottom bearings where scale has been permitted to reach the bearing. One of our blooming mills, with a suitable scale guard, gets excellent life with bottom fabric bearings.

Now, we have put composition bearings on some mills and taken them off because of not having sufficient life, but as I mentioned before, in most cases, the reason we have taken them off was because we were unable to remove the scale condition. Scale will quickly ruin fabric bearings. Another condition which forbids the use of fabric bearings is scaly or fire cracked roll necks.

Fred A. Horn: Do you have any data on the power savings on composition bearings on blooming mill rolls?

K. E. McHenry: On a blooming mill, when I was speaking of power savings, I was referring to the use of a composition bearing with water as a lubricant alone.

Now, when you introduce grease and you also are using a mill that is a starting and stopping mill, the starting and stopping torque on composition bearings is very high, and I would say as far as power was concerned, you would not expect much change in power consumption. You would not use any more, but you would not have any appreciable savings on a blooming mill.

Fred A. Horn: I notice also in your discussion that it primarily touched on laminated fabric bearings. I believe there are some being made with a macerated type of fabric. What is your opinion of this type?

K. E. McHenry: We use both types. However, I think the place where macerated type fabrics are mostly used and should be used are in a molded design type of bearing. There you have to either use a macerated type molded bearing or it becomes quite expensive to cut a laminated bearing sometimes to fit this design. You get into a matter of economy, of trying possibly the macerated design, and then obtaining the experimental cost of a laminated design and seeing if it is worth the difference.

Fred A. Horn: You mentioned the totally enclosed type. Were you thinking of a possible application like a back-up roll on a strip mill?

K. E. McHenry: That is a possibility, but I was not thinking of anything quite that large. I was thinking of smaller mills, roller line shaft bearings 5 to 10 in. in diameter and items of that nature where this neck bearing is being used. I am quite sure that it is not used on anything quite that large as yet. However, there is a possibility.

1956

AISE CONVENTION AND EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 25, 26, 27, 28

TEMPERATURES AND HEAT FLOW

in the hearths of blast furnaces with and without underhearth cooling

The all-carbon hearth should have less salamander penetration than combinations of ceramic and carbon with equal cooling . . . . underhearth cooling is feasible from a thermal standpoint and will reduce size of salamanders, but from a thermal standpoint will not affect frequency of sidewall breakouts.

By PROFESSOR V. PASCHKIS
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and
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▲IN a previous paper[1]* the temperature distribution in the bottom of blast furnaces was discussed for a few different lining arrangements. The results indicated the possibility that a different combination of refractory and carbon might, from a thermal viewpoint, be more satisfactory. In the present paper the results of an exploration of such a possibility are presented. After completion of the first paper (this term will be used throughout for the paper mentioned in reference 1) information was obtained regarding underhearth cooling in England[2] and Sweden[3]. Therefore, designs with underhearth cooling have been included in the present study.

The actual thermal design of underhearth coolers and cooling staves depends on the mechanical arrangements, and therefore a generalized presentation is not practical. However, a few basic considerations regarding the thermal aspects of cooler design are included.

Since the work covered by this report is a direct continuation of that covered by the first paper, knowledge of the latter is assumed; it is not possible to repeat all general considerations. The following summary must suffice.

1. All considerations are purely thermal; preferences in lining, from the viewpoint of mechanical erosion or chemical corrosion, are disregarded.
2. The study is a mathematical one utilizing the heat and mass flow analyzer, an electric analog computer. Certain relationships developed by one of the authors[4] greatly reduced the amount of labor.
3. It is assumed that at the initial contour a constant temperature of 2700 F is maintained and that the entire "salamander space" is filled with stagnant liquid iron.
4. Thus, the final 2100 F isotherm presents the limit of iron penetration.
5. All properties are assumed to be independent of temperature; the following values have been used:
   Thermal conductivities (in Btu per ft per hr per degree F)
   Refractory 1.33 (in Btu per ft per hr per degree F)
   Carbon brick 3.44 (in Btu per ft per hr per degree F)
   Carbon block 8.31 (in Btu per ft per hr per degree F)
   Liquid iron 9.20 (in Btu per ft per hr per degree F)
   Concrete 1.00 (in Btu per ft per hr per degreee F)
   Boundary conductance between lining and cooling staves 5.17 (in Btu per sq ft per hr per degree F unless otherwise noted).
   Solidus point of iron 2100 F.

UNDERHEARTH COOLING

In the investigation of underhearth cooling, the assumption was made that at a certain depth below the original furnace bottom a constant temperature is maintained. Actually this would be very difficult to

*Numbers in parentheses refer to Bibliography at end of paper.

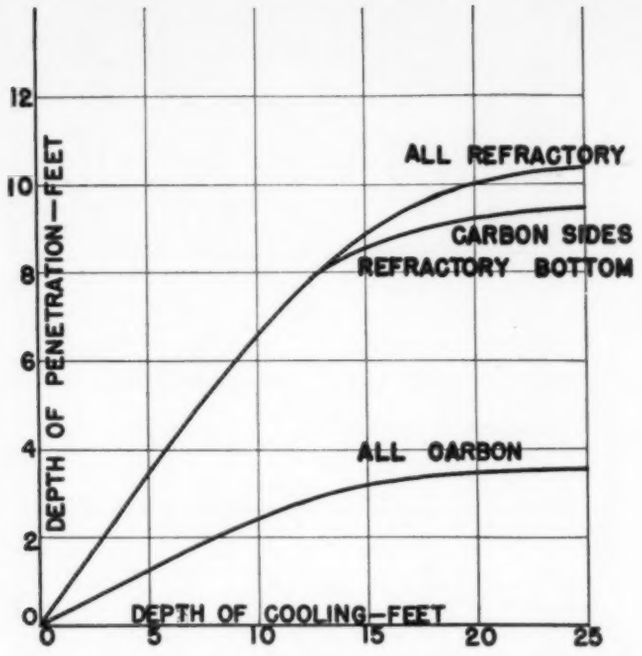


Figure 1 — Depth of penetration at center of furnace is given for various locations of underhearth cooling in a 28-ft furnace.

achieve because of the resulting local differences in rate of heat extraction.

The depth at which this constant temperature is assumed to be maintained, and the temperature level itself govern the depth of penetration, and their influence was studied. In the case of underhearth cooling, the cooling staves were assumed to extend down to the cooled level of the underhearth.

The level of underhearth cooling was studied for the three following designs:

1. All-ceramic lining (corresponding to "design I" of the first paper).
2. Ceramic bottom blocks; carbon side walls.
3. All-carbon lining.

Wherever there is carbon used, a layer of 1.125 ft radial thickness was assumed to be brick; all other carbon was assumed to be block. The level of the cooling was to be selected in such a manner that after penetration, the 2100 F isotherm should intersect the axis of the furnace at a depth 7.0 ft below the iron notch. Since the iron notch was assumed to be 1 ft-9 in. above the original contour, the depth of penetration was assumed to be 5 ft-3 in. below the original contour.

To find the proper level of undercooling it was assumed that such a level could be maintained at a uniform temperature of 100 F. There is no way of computing the proper level of underhearth cooling directly. Rather, the depth of penetration at the center of the furnace was investigated for several assumed levels of the underhearth cooling. Results are shown in Figure 1 for the three furnaces.

The depth of underhearth cooling is shown on the horizontal (abscissa) axis, and the depth of penetration on the vertical (ordinate) axis. If, by way of example, the underhearth cooling is located at 10 ft below the original contour, iron will penetrate, and therefore the salamander will extend to a depth of 6.6 ft in case of the furnaces with all-refractory lining or with refractory bottom and carbon sides. In this case, also, the all-carbon lining will have a salamander extending only to 2.4 ft below the original level.

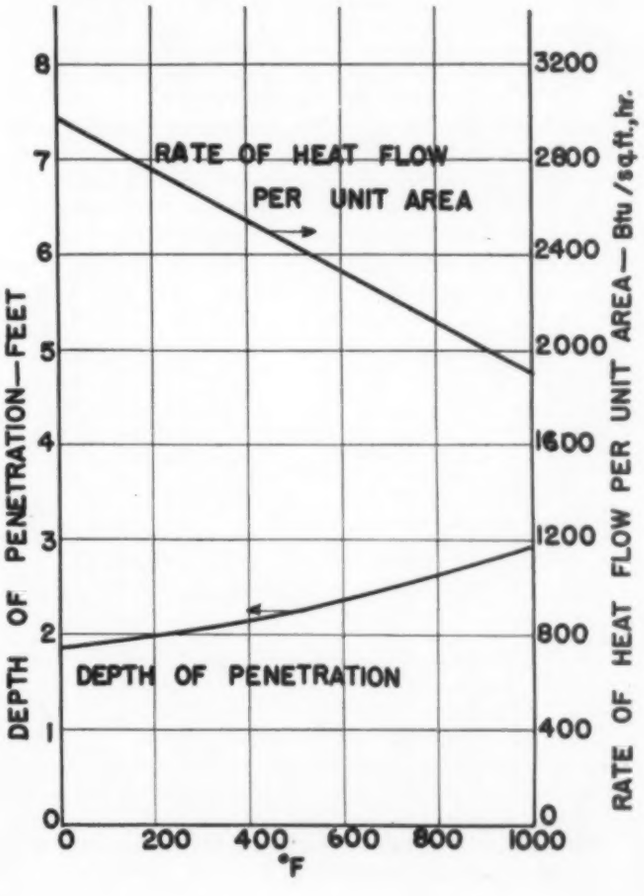
It may be seen that the all-refractory lining and that with refractory bottom and carbon sides show no difference if the cooling level is anywhere between the original contour and 11.5 ft below; only if the cooling level is lower than 11.5 ft do the two designs differ with regard to iron penetration at the center of the furnace.

It may also be seen that the depth of penetration of 5.25 ft (5 ft.-3 in. below the original contour; see above) is achieved with a depth of the underhearth cooling of 7.8 ft in case of the all-ceramic lining or the lining with ceramic bottom and carbon lining. In case of the all-carbon lining a salamander of 5.25 ft thickness is not reached, independent of the depth of cooling. In other words, with a carbon lining the salamander will not reach the level of 5 ft-3 in. even if the underhearth cooling would be very far away or practically non-existent.

Since in the case of all-carbon lining the penetration never reaches the critical value, all further studies were made with a depth of the underhearth cooling at 7.8 ft, which is the value found necessary for the all-ceramic lining.

It may now be asked—how sensitive is the depth of penetration against variations in the temperature at the level of underhearth cooling? For the all-carbon lining, results are shown in Figure 2 for a simplified case. Values hold for a furnace of very large diameter, in fact, of so large a diameter that the penetration along

Figure 2 — Depth of penetration and rate of heat extraction per unit area is shown vs. temperature of underhearth cooling.



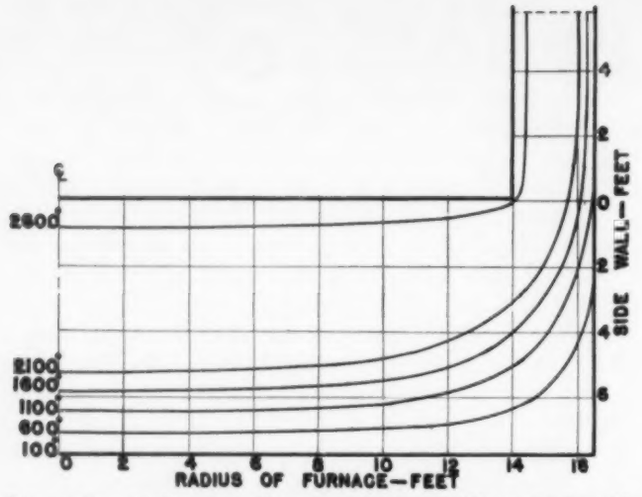


Figure 3 — Isotherms after penetration with underhearth cooling are given for all refractory lining. The entire space between the original contour and the 2100 F isotherm is assumed to be filled with iron, k=9.2 Btu per ft per hr per degree F.

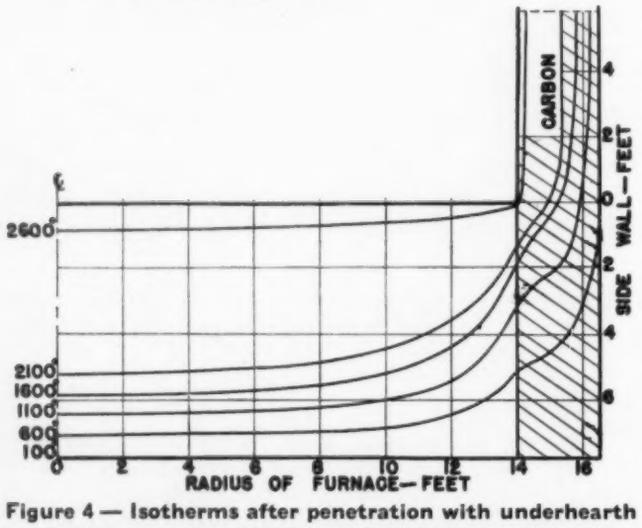


Figure 4 — Isotherms after penetration with underhearth cooling are given for refractory bottom with carbon sides. The entire space between the original contour and the 2100 F isotherm is assumed to be filled with iron, k=9.2 Btu per ft per hr per degree F.

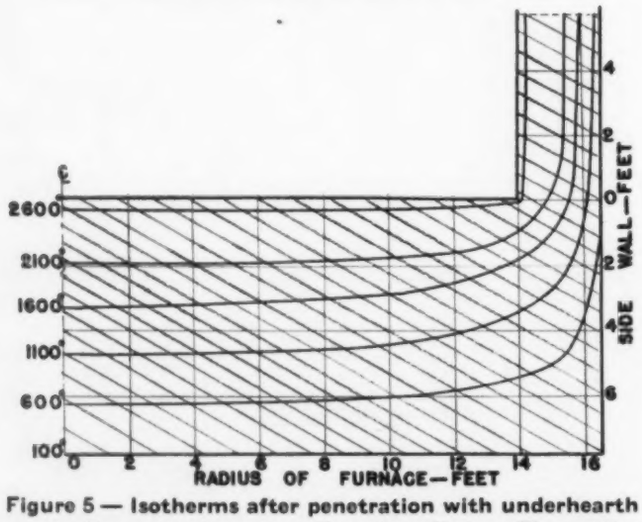


Figure 5 — Isotherms after penetration with underhearth cooling are given for all carbon lining. The entire space between the original contour and the 2100 F isotherm is assumed to be filled with iron, K=9.2 Btu per ft per hr per degree F.

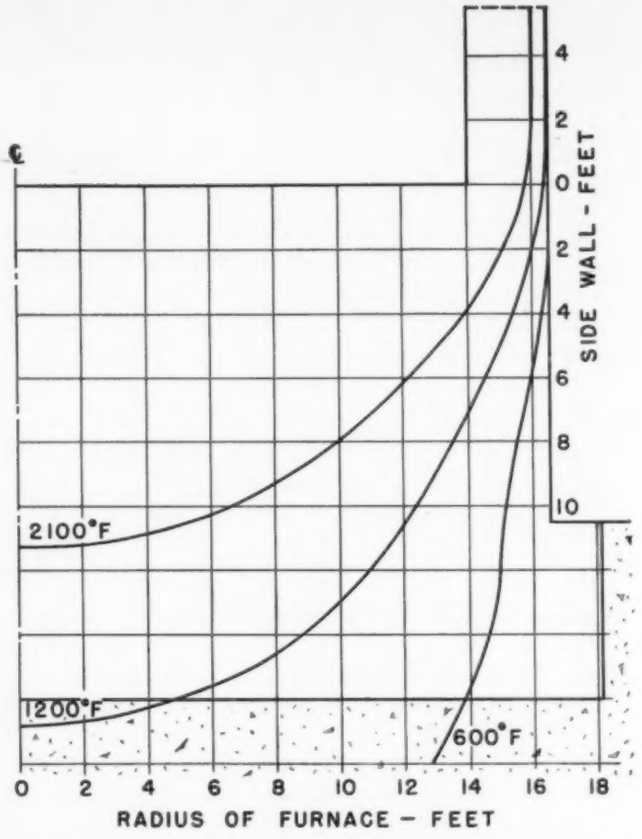


Figure 6 — The 2100, 1200, and 600 F isotherms for all ceramic lining without underhearth cooling are given.

the axis is not influenced by the cooling from the sides. Comparison of the values here obtained with those of Figure 1 show that the furnace of 28 ft is big enough to make the values of Figure 2 practically applicable.

The temperature at which the level, 7.8 ft below the original contour, is being held is plotted as abscissa, the depth of penetration on the left ordinate scale, and the rate of heat extraction per unit area on the right ordinate scale. The heat extraction values will be discussed later. It may be seen that even a considerable increase of temperature at the level of underhearth cooling will not increase the depth of penetration greatly.

THE THREE BASIC DESIGNS

The temperature distribution is shown by indicating the isotherms with their respective temperatures. Figure 3 holds for the all-ceramic lining with underhearth cooling. Figure 4 for the furnace with ceramic bottom and carbon sides with underhearth cooling. Figure 5 for the all-carbon lining with underhearth cooling; and Figures 6, 7 and 8 for furnaces without underhearth cooling.

It is very interesting to compare the results with and without underhearth cooling. It may be seen that at the danger points where a breakthrough is most likely to occur (at the sides near the level of the furnace bottom), the underhearth cooling has but little influence on the position of the freezing lines; but at and near the center of the furnace the influence is great.

Thus, the major result of underhearth cooling is a reduction of the salamander. Figures are shown in Table I.

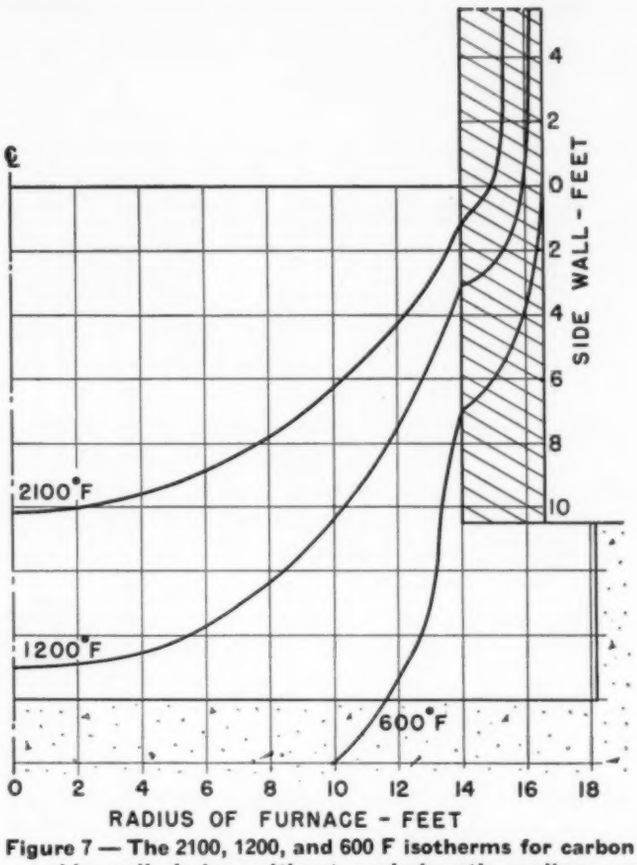


Figure 7 — The 2100, 1200, and 600 F isotherms for carbon side wall design without underhearth cooling are given.

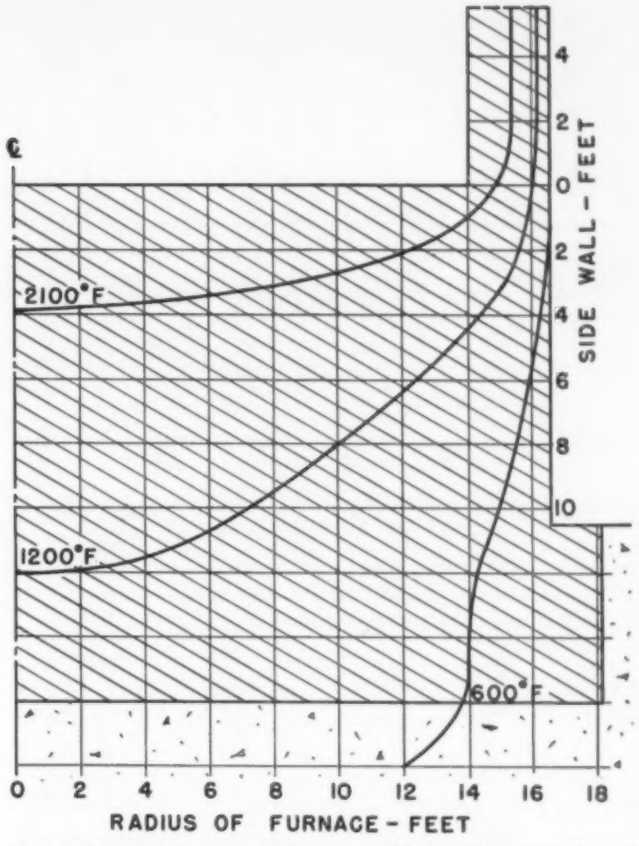


Figure 8 — The 2100, 1200, and 600 F isotherms for all carbon lining without underhearth cooling are given.

VARIATION OF CARBON SECTION

In the first paper it was stated that possibly a different arrangement of carbon and refractory might result in a more advantageous design. Following this idea a number of combinations have been investigated. Since the 2100 F isotherm is the one characteristic which determines the depth of penetration, only this one isotherm is shown hereafter for each of the several designs. Figures 9, 10, 11, 12, 13, 14, 15 and 16 show the 2100 F isotherms for each design, together with an outline of the design. For the sake of comparison, the all-carbon and the all-refractory cases are included; their 2100 F isotherms are repeated in each of the Figures 9-16.

These figures hold for the case of underhearth cooling. For the furnaces without underhearth cooling similar results were obtained. For experimental reasons it would have been impractical in the computing experiments to study exactly the same geometric arrangements as with underhearth cooling. The results shown hereafter for furnaces without underhearth cooling were obtained by interpolation. Figures 17, 18, 19, 20, 21, 22 and 23 show the 2100 F isotherms for furnaces without underhearth cooling, together with an outline

TABLE I

Summary of Calculations

Extent of carbon		Volume of		Figure reference in this report		Volume of salamander		Total rate of heat loss		
								With		Without
Radial (ring) width, ft	Axial thickness, ft	Carbon	Refractory	With	Without	With	Without	Underhearth cooling		
		cu ft	cu ft	Underhearth cooling		Underhearth cooling		Radial cooling staves, 10^6 Btu/hr	Axial underhearth cooling, 10^6 Btu/hr	Radial cooling staves, 10^6 Btu/hr
						cu ft	cu ft			
0	0	1410	6700	9	17	3603	5564	2.74	0.569	2.94
0	3.9	2360	5750	10	18	3228	5002	3.00	0.534	3.35
1.0	3.9	2680	5430	11	19	3159	4940	3.15	0.529	3.37
3.5	3.9	3410	4700	12	20	3017	4940	3.23	0.527	3.39
0.0	7.8	3310	4800	13	7	3158	4714	2.97	0.637	3.48
1.0	7.8	3950	4160	14	21	3024	4384	3.13	0.790	3.53
3.5	7.8	5410	2700	15	22	2592	3777	3.14	1.090	3.62
7.0	7.8	6910	1200	16	23	2413	3367	3.18	1.490	3.70
All refractory		....	8110	3	6	4710	6205	2.02	0.576	2.24
All carbon		8110	....	5	8	1767	2266	3.15	1.760	3.91

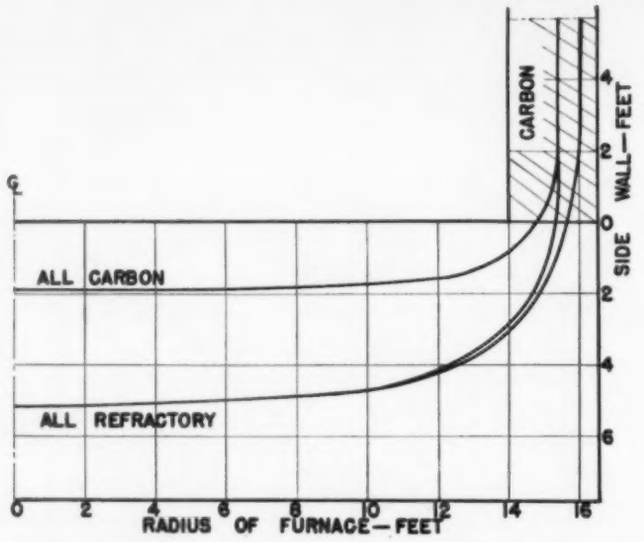


Figure 9 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 0 ft.

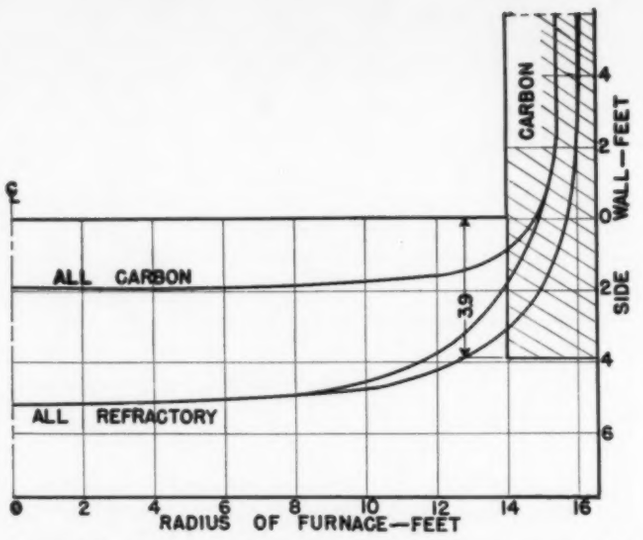


Figure 10 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 3.9 ft.

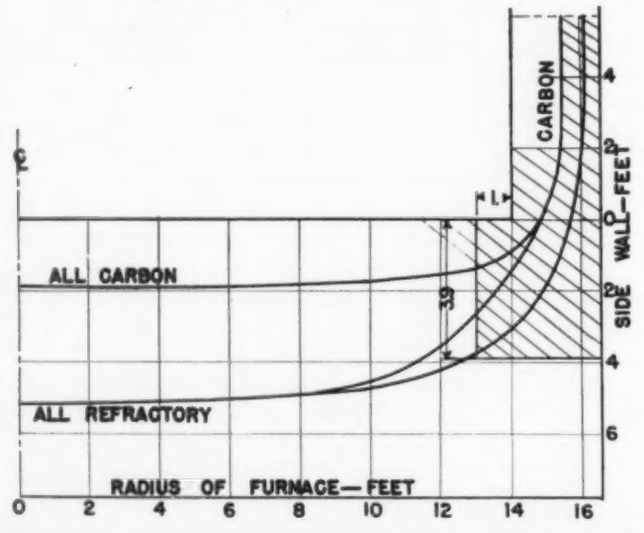


Figure 11 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 1.0 ft and axial thickness of 3.9 ft.

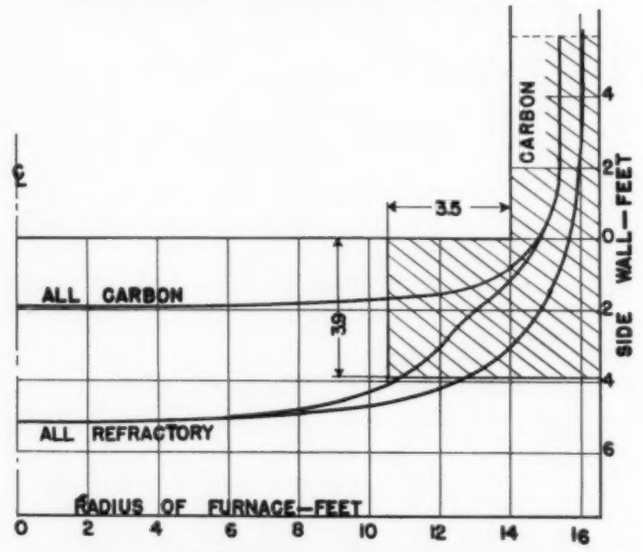


Figure 12 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 3.5 ft and axial thickness of 3.9 ft.

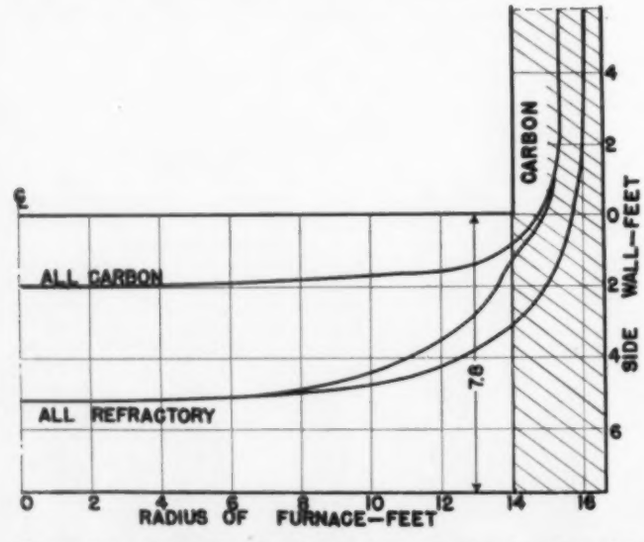


Figure 13 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 7.8 ft.

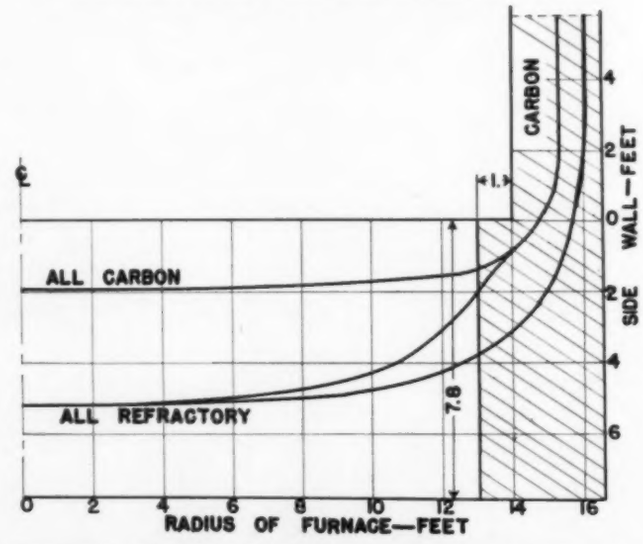


Figure 14 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 1.0 ft and axial thickness of 7.8 ft.

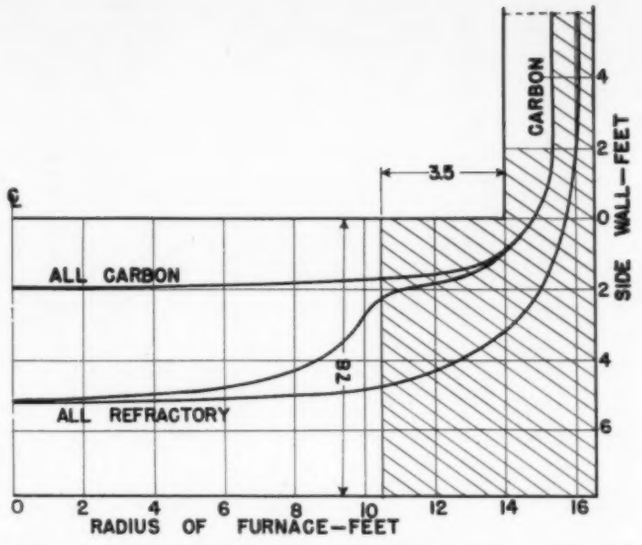


Figure 15 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 3.5 ft and axial thickness of 7.8 ft.

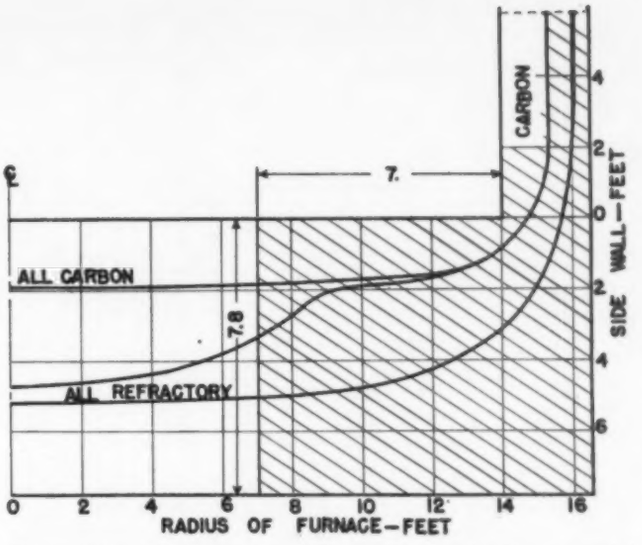


Figure 16 — The 2100 F isotherm is shown for furnace with underhearth cooling and a carbon bottom design with radial width of 7.0 ft and axial thickness of 7.8 ft.

of the design. Again the main difference between the furnace with and without underhearth cooling is in the size of the salamander.

The conditions are summarized in Table I, which includes also the required volume of refractory and carbon and also the size of the salamanders.

The total volume is that of the cylinder extending radially to the outside diameter of the wall (16.5 ft) and axially from the original level to a depth 7.8 ft below, plus the ring of side wall (16 ft to 16.5 ft) to a height of 5.5 ft above the original contour (i.e., up to the cinder notch).

The heat losses are discussed later in this report.

In general, linings may be considered safer the farther the 2100 F isotherm is from the outside wall. A price that must be paid for such safety is to be seen in the increased volume of carbon, which is more expensive than refractory.

Figure 17 — The 2100, 1200, and 600 F isotherms are shown for furnace without underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 0 ft.

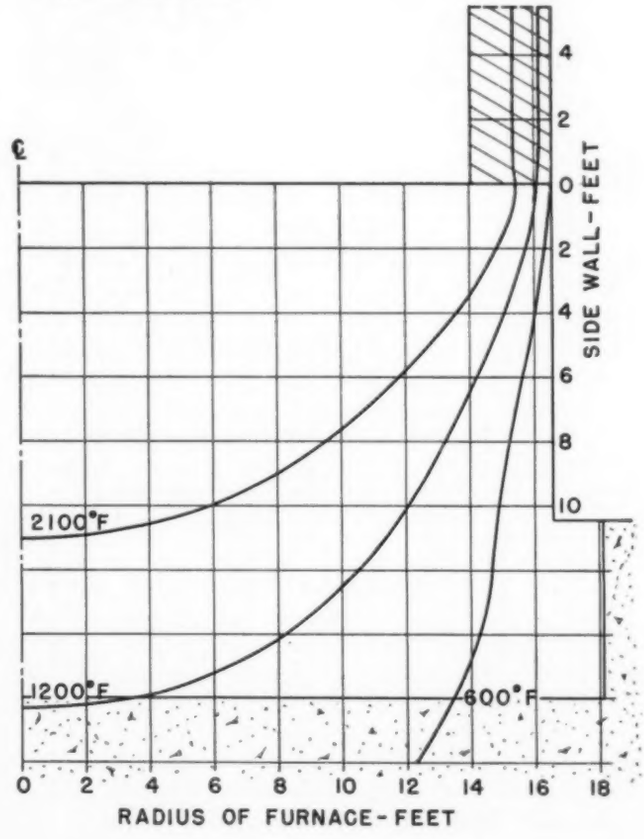
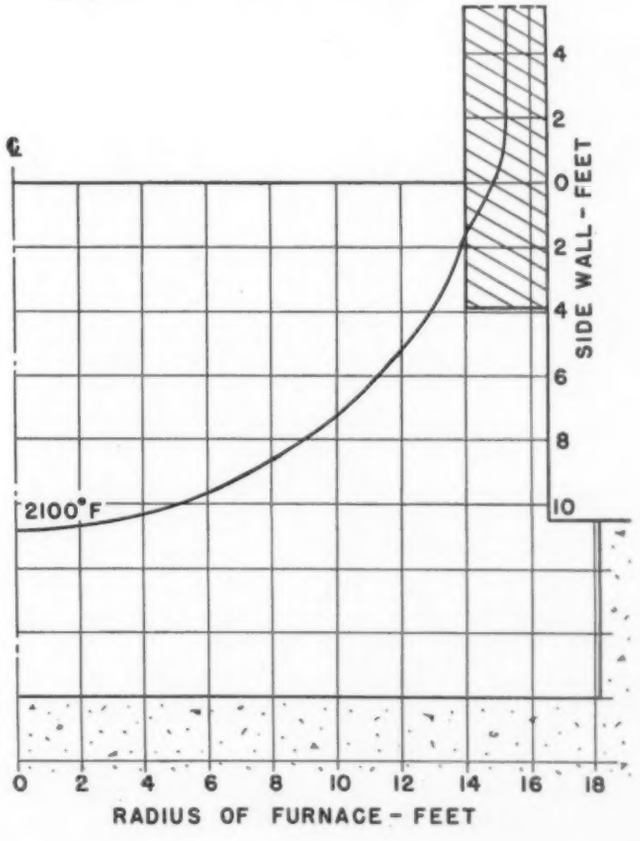


Figure 18 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 3.9 ft.



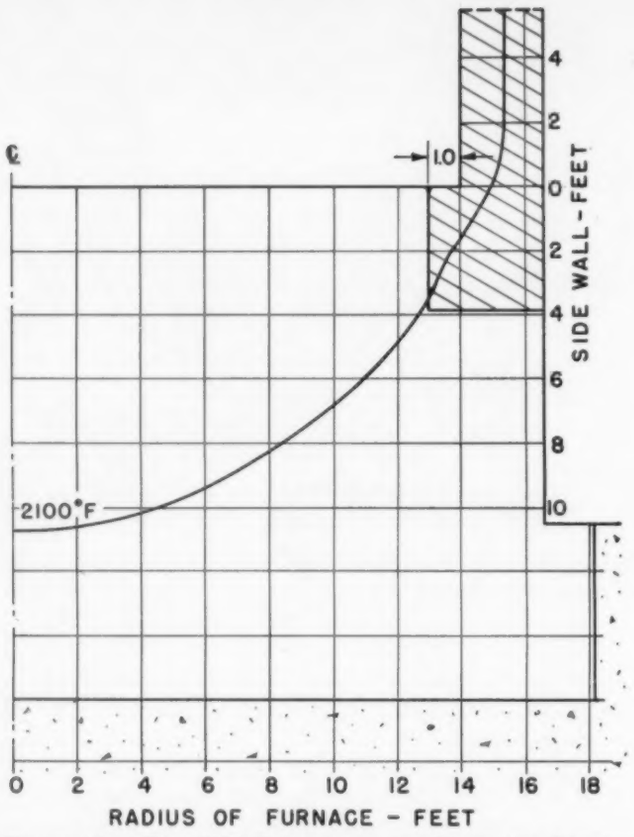


Figure 19 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 1 ft and axial thickness of 3.9 ft.

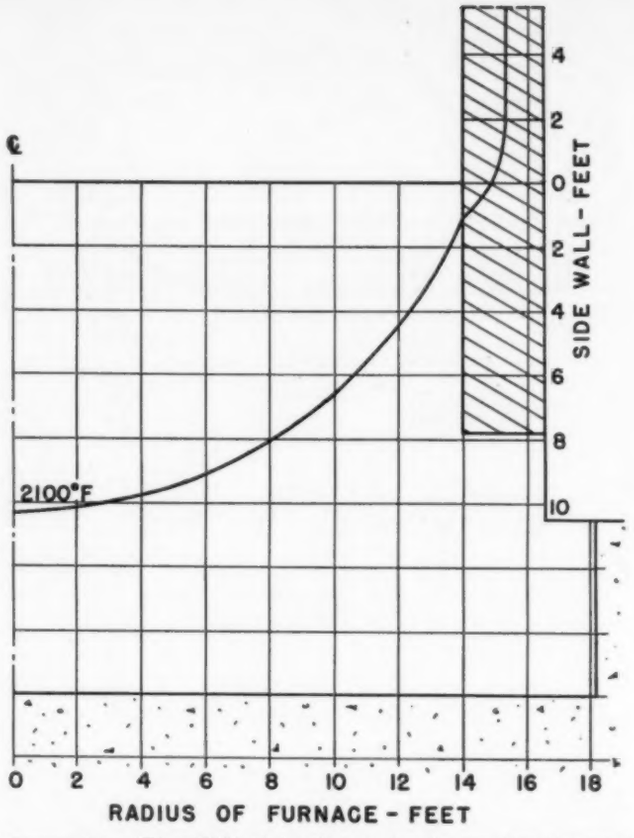


Figure 20 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 0 ft and axial thickness of 7.8 ft.

Figure 21 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 1 ft and axial thickness of 7.8 ft.

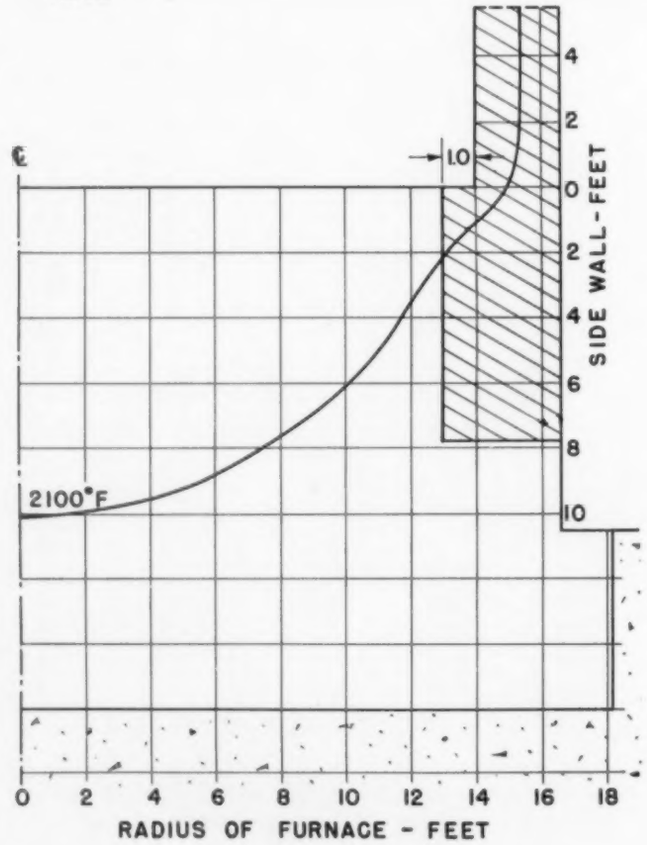
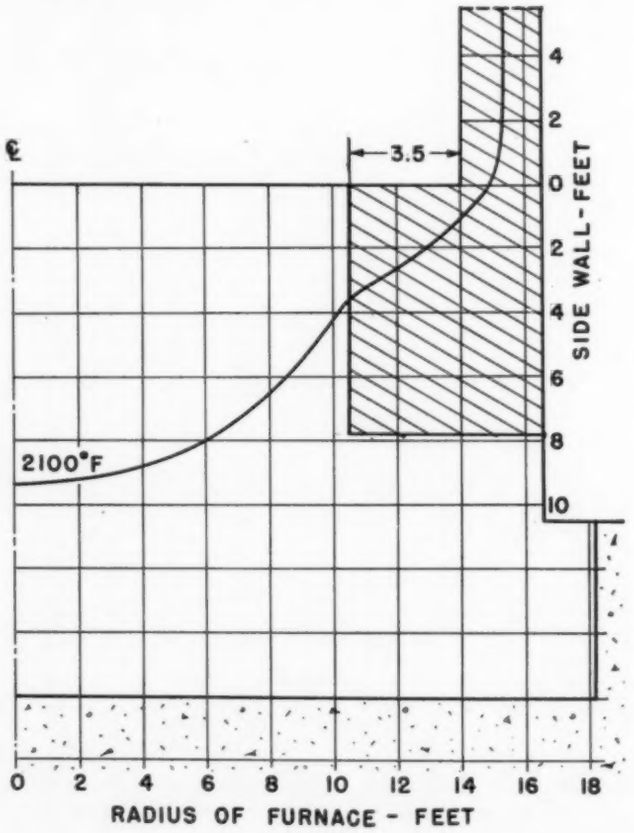


Figure 22 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 3.5 ft and axial thickness of 7.8 ft.



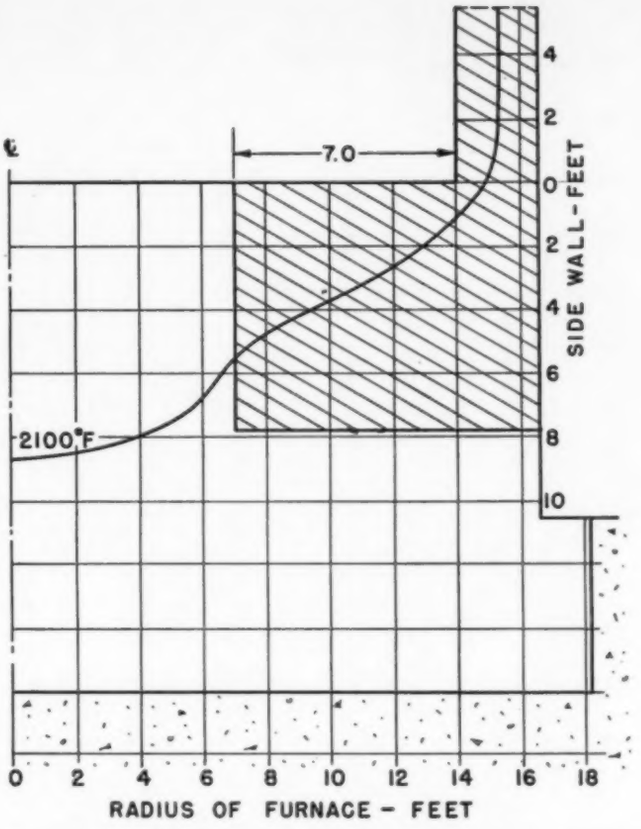


Figure 23 — The 2100 F isotherm is shown for furnace without underhearth cooling and a carbon bottom design with radial width of 7 ft and axial thickness of 7.8 ft.

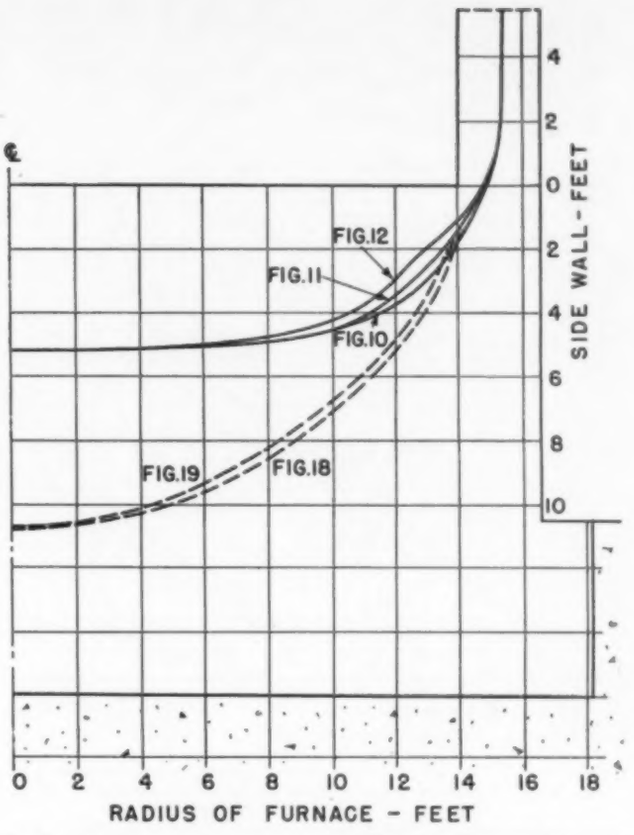


Figure 24 — Chart summarizes 2100 F isotherms for various bottom designs. Designs of Figures 10, 11, and 12 are given by solid lines, and designs of Figures 18 and 19 by broken lines.

If the 3.9 ft layer of carbon extends radially far towards the center, the part of such carbon inside the 2100 F isotherm will be replaced by the salamander (according to the assumption). Therefore, the 2100 F isotherm is the same if, in this area, there is originally carbon or refractory. Thus, the isotherms shown in Figure 12 hold also for the case of carbon extending to an axial thickness of 3.9 ft and a radial ring width of 7.0 ft. Similarly, the isotherms shown in Figure 19 hold also for the case of an axial thickness of 3.9 ft and a radial ring width of 3.5 ft and 7.0 ft.

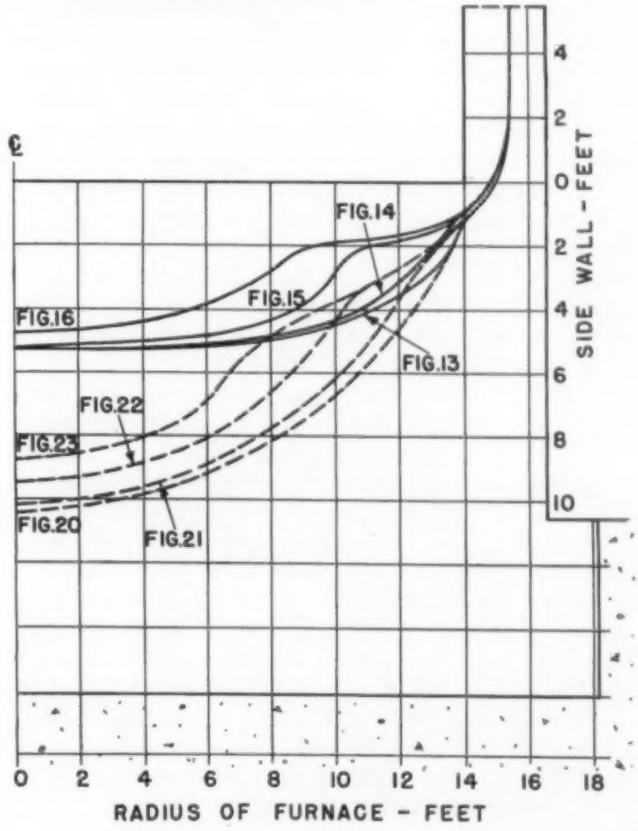
In order to summarize the results Figures 24 and 25 are shown; they contain the 2100 F isotherms previously presented. Figure 24 refers to the cases with an axial thickness of 3.9 ft, and Figure 25 to those with an axial thickness of 7.8 ft. The isotherms for underhearth cooling are shown as solid lines; those for furnaces without underhearth cooling are shown as broken lines, branching from the solid lines, where the isotherms take a markedly different shape. The isotherms are identified by the figure numbers.

HEAT EXTRACTION

Heat extraction was studied exhaustively for underhearth cooling (where both the underhearth and the cooling staves are concerned) and for no underhearth cooling (where only staves have to be considered).

Maintenance of a certain temperature (e.g., 100 F) at the level of underhearth cooling, or at the side wall, by means of cooling staves implies heat extraction at

Figure 25 — Chart summarizes 2100 F isotherms for various bottom designs. Designs of Figures 13, 14, 15, and 16 are given by solid lines, and designs of Figures 20, 21, 22, and 23 by broken lines.



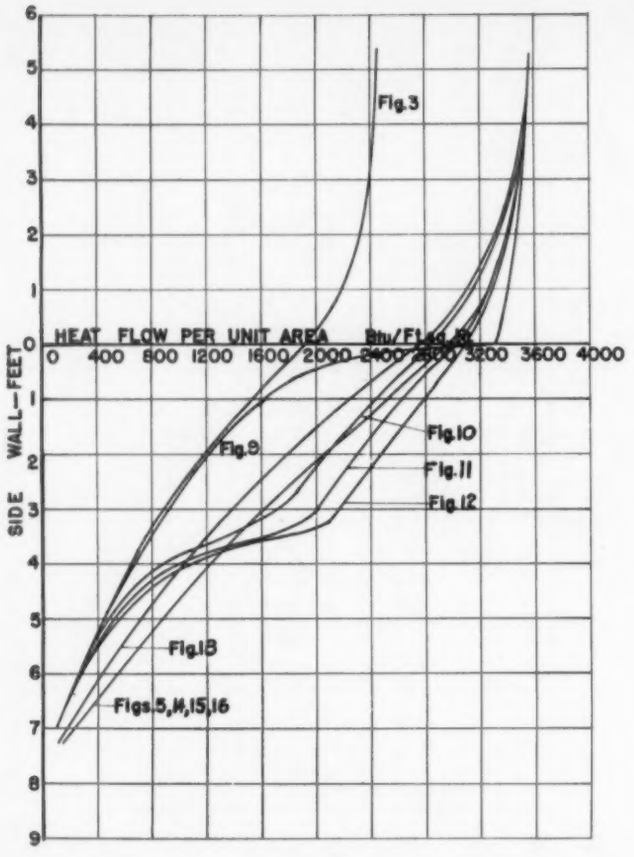


Figure 26 — Rates of radial heat flow per unit area to the cooling staves are given for furnace with underhearth cooling.

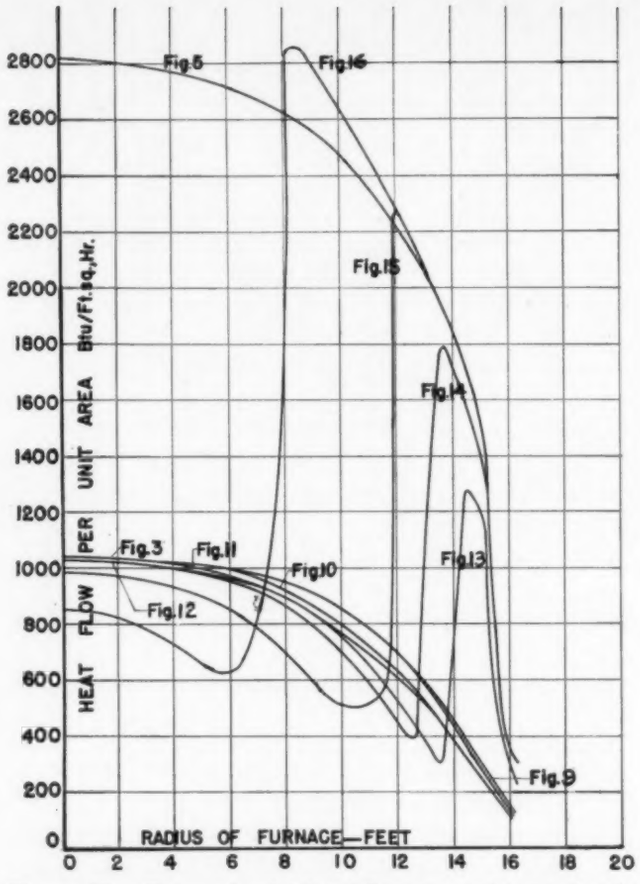
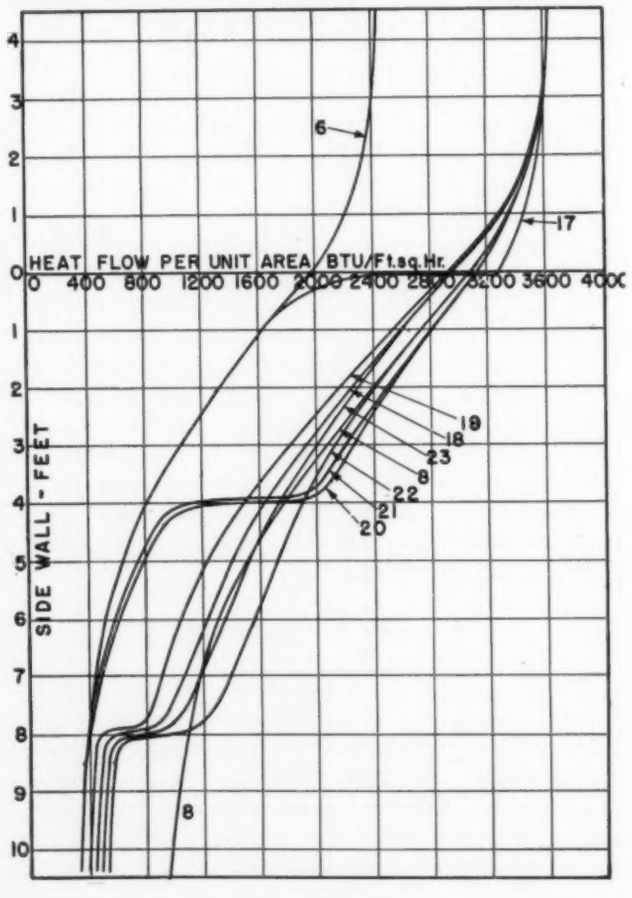


Figure 27 — Rates of axial heat flow per unit area to the underhearth cooling system are given by curves.

Figure 28 — Rates of radial heat flow per unit area to the cooling staves without underhearth cooling are given.



these surfaces. If the rate of heat extraction becomes very large, serious design problems may be encountered: the required rate of air flow may become excessive; water cooling may become necessary, which is considered unsafe by some operators, etc. Therefore, a study was made of the heat extraction. This extraction varies from one location to another, and therefore the curves show the rates of heat extraction per unit area.

Figure 26 shows the radial heat loss into the cooling staves, while Figure 27 shows the axial heat loss extracted through the underhearth cooler. The values of total heat loss, axial and radial, are listed in the last two columns of Table I. The "safest" furnace, with the greatest distance of the isotherm from the outside contour, has the greatest rate of heat loss (all-carbon); the "unsafest" furnace has the lowest heat loss (all-refractory). The terms "safest" and "unsafest" are meant only to refer to thermal breakthrough.

In the figures the individual curves are marked by reference to the figures containing the 2100 F isotherm for each different design (Figures 9 to 16). The discontinuities in the curves occur at the points of change of material. The highest rates of heat extraction, in the order of magnitude of 3000 Btu per sq ft per hr and more, are hard to achieve, particularly in underhearth cooling if water is considered unpermissible. Reference is made also to Figure 2, where the rate of heat extraction at the center of the furnace per unit area is plotted against the temperature of the cooled surface. As the temperature of the latter increases, the rate of heat

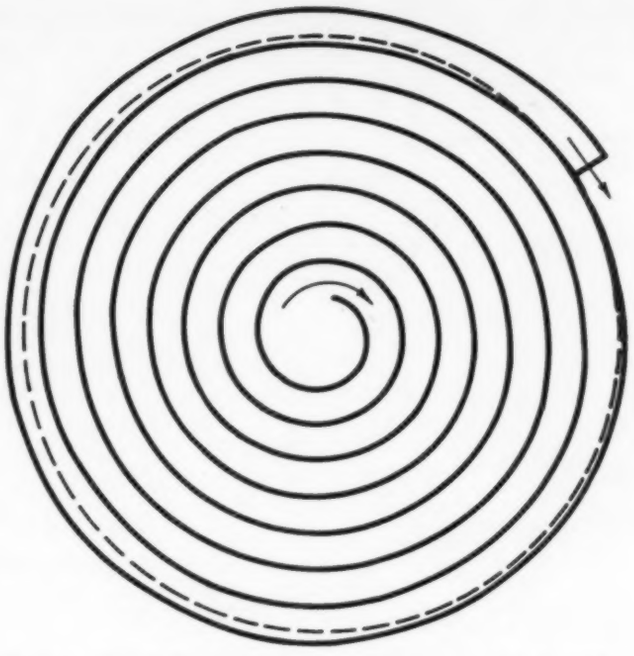


Figure 29 — Schematic diagram of single spiral underhearth cooling system.

Figure 30 — Schematic diagram of four-spiral underhearth cooling system.

extraction drops very markedly. Thus, it may be possible to overcome the difficulties by increasing the temperature of the surface in underhearth cooling. Penetration increases but slightly, and the rate of heat extraction drops rapidly.

For the case of no underhearth cooling, the heat extraction through the staves is shown in Figure 28.

STUDIES OF UNDERHEARTH COOLING

1. *Materials considered* — The only cooling means considered here are water and air. Cooling by liquid metals, oil, and other high-boiling liquids was not studied because the design complications involved seemed unwarranted; the simpler way of cooling by air or water appeared satisfactory.
2. *Range of investigation* — Coolant quantities depend on the boundary conductance, and both are tied in with the geometric design of the cooler. No attempt was made either to present a complete design or to cover, even briefly, all possible designs. Instead, a few modifications of two basic design principles were explored; in both, the coolant enters at the center of the underhearth. One design provides spiral flow of the coolant, the other radial flow; one or several channels provide the total cross section, and each channel may have a constant or varying cross section. (See Figures 29, 30, 31.)

   As the first step, the study covers the case of the cooler applied at the level of the 100 F isotherm (Figure 5). Then application at a higher isotherm was considered; for this case the results are somewhat less accurate. However, it is believed that the error incurred by applying this work to a case where cooling is used at a higher level between 150 F and 400 F is not significant.
3. *Cooler applied at 100 F level.*

   a. Water cooling.
   Since temperature rise is nearly independent of water temperature, calculations were made for a water temperature just above the freezing point. The values hold for water at ordinary temperature. Conditions are summarized in Table II.

Figure 31 — Schematic diagram of six-channel radial underhearth cooling system. The 12-channel design is similar.

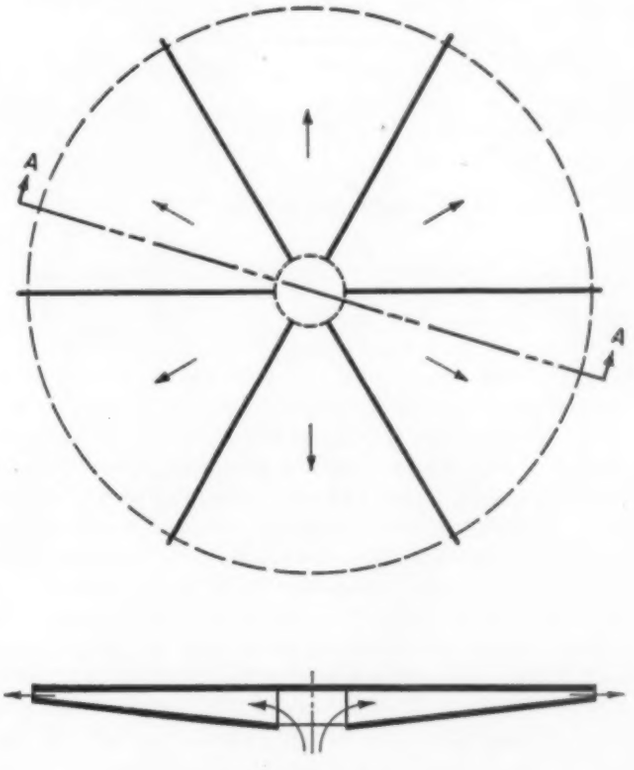


TABLE II

Underhearth Cooling with Water, 100 F Level

Description of channel				Boundary conductance, h			Total water quantity, gpm	Temperature rise, F
				h_{in}	h_{out}	h_{out} min		
Type	Number	Width, ft	Height, ft	Btu per sq ft per hr per degree F				
Spiral	Single	1 (1)	0.57 (1.78)	41.5	22.4	22.4	60	54.6
Spiral	Four	1	0.5	41.5	41.5	11.9	105	52.8
Radial	Six	1 (16.25)	1 (0.0616)	41.5	64	5.02	685	8.3

TABLE III

Underhearth Cooling with Air, 100 F Level

Description of channel				Boundary conductance, h			Total air quantity, scfm	Temperature rise, F
				h_{in}	h_{out}	h_{out} min		
Type	Number	Width, ft	Height, ft	Btu per sq ft per hr per degree F				
Spiral	4	0.5	0.5	94	94	27.3	55300	26.8
Radial	12	0.5 (8.5)	0.5 (0.0294)	94	31.9	21.9	175000	16.3

TABLE IV

Underhearth Cooling with Water, 150 F Level

Description of channel				Boundary conductance, h			Water quantity, gpm	Temperature rise, F
				h_{in}	h_{out}	h_{out} min		
Type	Number	Width, ft	Height, ft	Btu per sq ft per hr per degree F				
Spiral	4	1	0.5	47	53	8.6	146	25
Radial	6	1 (16.25)	1 (0.0616)	47	77.5	6	485	9.6

TABLE V

Underhearth Cooling with Air, 400 F Level

Description of channel				Boundary conductance, h			Air quantity, scfm	Temperature rise, F
				h_{in}	h_{out}	h_{out} min		
Type	Number	Width, ft	Height, ft	Btu per sq ft per hr per degree F				
Spiral	4	0.5	0.5	9.1	9.63	8.57	3160	275
Radial	6	1 (16.25)	0.5 (0.0308)	9.1	15.2	1.79	10500	142

The cross-sectional areas of the channels mentioned in Table II are constant over the entire length with the exception of the arrangement of the first line (single spiral). For this case the cross-sectional area increases from the entrance to the exit. Cross-sectional area in the arrangements in Tables III, IV, and V are constant over the entire length.

If in the columns for width and height two figures are shown, the first refers to the inlet, the other in bracket to the outlet. The water quantities are so computed as to give at the inlet side the required cooling; from this quantity the h value at the outlet follows. Since, according to Figure 27, the cooling requirement on the outside are less, the h_{out} min value computed from this requirement is less than the achieved value.

b. Air cooling.

Table III shows conditions for that case, based on an air inlet temperature of 70 F.

The same remarks hold as for Table II; the linear air velocities are quite high—in the order of magnitude of 800 to 900 fps.

4. *Cooler applied to higher temperature level.*

a. Water cooling.

The inlet temperature is selected at 90 F; the

isotherm to be held constant is the 150 F line. Results are presented in Table IV.
For explanation of the columns see the remarks to Table II.

b. Air cooling.

The inlet temperature was again selected at 70 F. Since the case of air cooling a leak is less serious than in the case of water cooling, the temperature of the constant level was taken at 400 F. Results are shown in Table V.

Again, reference should be made to Table II for explanation of the columns.

In view of the high value of the isotherm to be held constant, the question arises whether part of the losses shown in Figure 26 for the sidewall would not have to be covered by the underhearth cooler. However, the heat loss from the sidewalls between the 100 F and the 400 F isotherms amounts to only a small fraction of the heat extraction through the bottom.

STUDIES OF COOLING STAVES

1. *Basic concepts* — It is generally recognized that the higher the rate of water flow in the cooling staves the greater the frozen thickness of iron will be. A limited study aimed at correlating rates of water flow with the degree of protection was made. Preliminary study reported hereafter holds for the condition of stagnant iron. Conditions may exist where iron flows continuously past a weak spot in the lining. In this case, heat is supplied continuously to the weak spot and consequently a breakthrough may occur. This case was not examined so far.

   In the main part of the study it was assumed that the outside surface of the lining is held at 100 F; here, as an extreme case, it is considered that the iron reaches the cooling staves. If the iron at the point of original contour is held at 2700 F constant, part of the iron will freeze eventually; and the heavier the rate of water flow, the greater the frozen thickness.

2. *Design* — The frozen thickness depends, of course, somewhat on the design of the staves. Figure 32 shows schematically the arrangement of tubes in the staves studied; the latter are assumed to be made of cast iron. However, as an alternative design an analysis was made for copper staves.

   The individual tubes in the wall of the staves result in an uneven heat extraction, the extraction being greatest directly under the tube and smallest under the midpoint between two staves.

   A rigorous analysis of this system is possible, but would be rather complex. In view of the approximate approach and based on analysis of the geometry, an average uniform thickness of 5 in. was assumed.

   The simplified design on which the study was made may obscure the fact that if the individual cooling staves are far apart, the possibility exists that a relatively hot zone develops over the area between two cooling channels. The uniform thickness assumed here does not allow for any such hot spots.

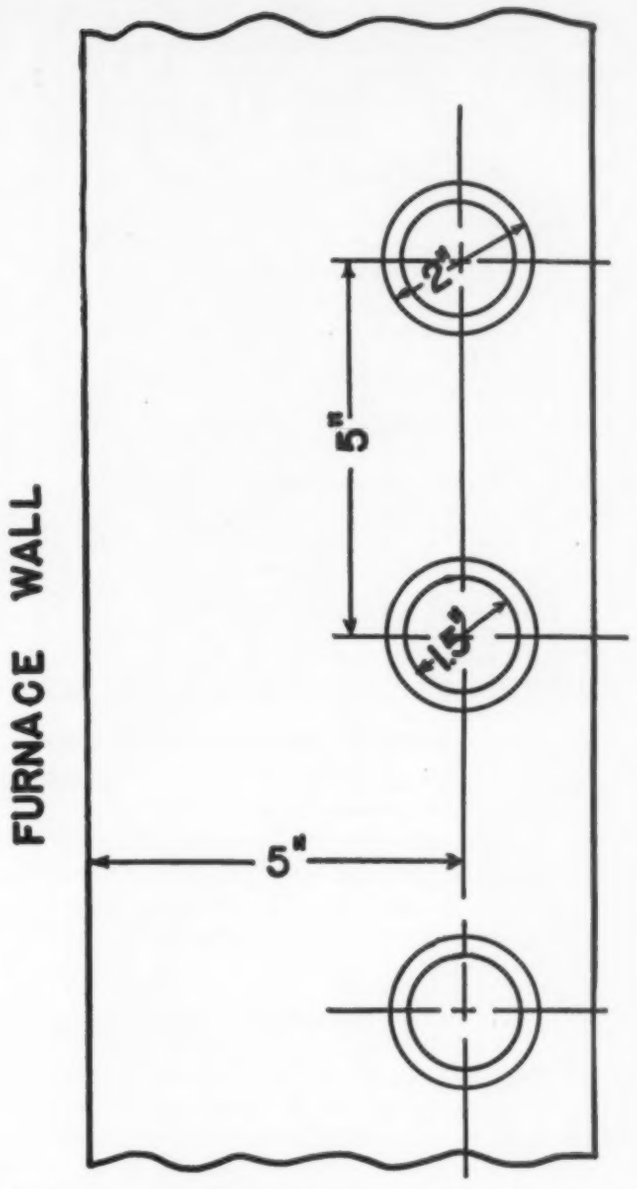


Figure 32 — Schematic arrangement of tubes is shown by top view of staves.

3. *Frozen thickness* — The thickness of the frozen layer for both cast iron and copper is plotted in Figure 33 (curves 1 and 2 respectively) against the rate of water flow expressed in millions pounds per hour (1 million lb per hr=2000 gpm). This figure of 2000 gpm is for the whole furnace and not each stave.

   For the same figure, curves 3 and 4 show, again for iron and copper respectively, the temperature rise of the water per foot of height of cooling staves. The use of the latter curves may be explained by the following example:
   Say that a rate of water flow of one million lb per hr is used; for cast iron staves one reads on the ordinate axis a temperature rise of 1.5 F per ft. If the staves are ten feet high and the water enters at 50 F, then the exit temperature of the cooling water will be:

$$50 + 10 \times 1.5 = 65 \text{ F}.$$

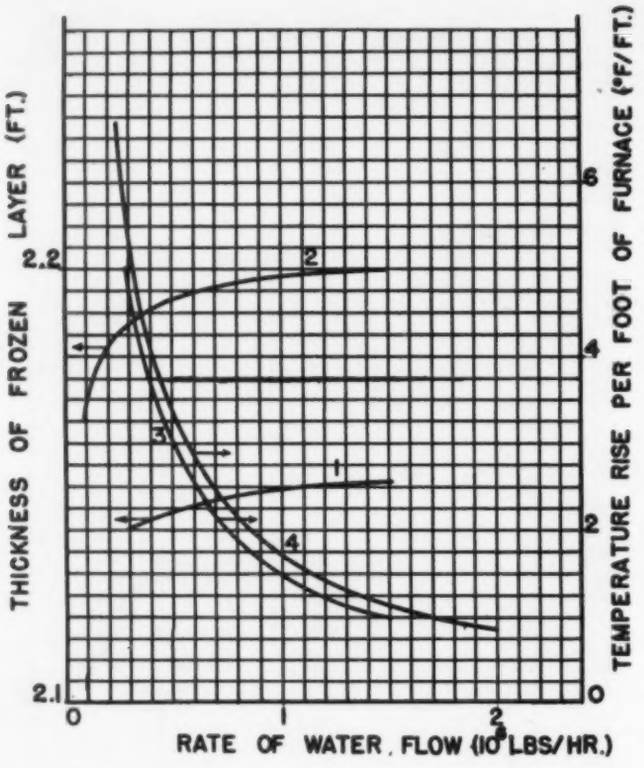


Figure 33 — Thickness of frozen layer and temperature rise of water is plotted vs. rate of water flow.

The calculations were carried out for a conductivity of the cast iron of 18.4 Btu per ft per hr per degree F and of the copper of 218 Btu per ft per hr per degree F.

SUMMARY

The following conclusions are based on thermal considerations only. Other factors which may affect the life of the furnace lining and its thickness, such as chemical erosion or corrosion are not included in this work, as their solution is not susceptible to the method of analysis which has been used.

1. Carbon is most effective on the outside, next to the furnace wall; that part of the lining which eventually is washed out by the iron can, from a thermal viewpoint, be made initially of refractory, or could be left out entirely.
2. Carbon lining on the outside does decrease depth of penetration materially.
3. Underhearth cooling results in a smaller salamander, but has no appreciable influence on depth of penetration near the side walls. Cooling water quantities are tabulated (Table II) and are in the order of magnitude of 60 to 685 gpm. Air quantities, in case of air cooling are tabulated in Table III, and vary from 55,000 to 175,000 cfm. Cooling at higher temperature levels than those mentioned in Tables II and III, requires increased water or air quantities.
4. The quantitative figures are accurate for the assumptions made. They hold only for the 28-ft furnace; in smaller furnaces both side cooling and underhearth cooling may have entirely different significance.

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4. "*A Study of Steady-state Temperature Distribution in the Bottom of Blast Furnaces*," by T. Mirsepassi, Ph.D. Thesis, Columbia University, 1955. (Microfilmed).

DISCUSSION

PRESENTED BY

J. C. FOSTER, Assistant Chief Construction Engineer, Bethlehem Steel Co., Bethlehem, Pa.

J. F. AGERTER, Superintendent Blast Furnaces, Youngstown Sheet & Tube Co., East Chicago, Ind.

C. M. SQUARCY, Superintendent Blast Furnaces, Inland Steel Co., East Chicago, Ind.

W. H. COLLISON, Plant Superintendent, Blast Furnaces and Coke Works, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

T. J. WILDE, Technical Sales Department, National Carbon Div., Union Carbide and Carbon Corp., New York, N. Y.

J. A. PIERCE Harbison Walker Refractories Co., Pittsburgh, Pa.

G. L. FRENCH, Master Mechanic, Blast Furnace Div., Bethlehem Steel Co., Bethlehem, Pa.

PROFESSOR V. PASCHKIS, Technical Director, Heat and Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y.

J. C. Foster: As a chairman of the committee of the AISE which advised and supported Dr. Paschkis in his work, I am going to review the background and purpose of this study. It was started about four years ago as an investigation of heat transmission and was finally confined to the blast furnace hearth. This report is on the final work and differs from most of the papers in the convention in that it consists of figures and theoretical curves; no operating comparisons or savings.

We all expect to be around here ten years from now, so that the popular idea of taking a look at the future might be beneficial. Specifically, what will the blast furnace of 1965 look like.

Certainly there will be continued progress in improved materials, and perhaps in blowing and blast heating. Your association believes that there will be major improvements in the cooling and refractory systems of the blast furnace with these concentrated on the heat transmission problems of the furnace hearth. Already, there are several furnaces with underhearth cooling.

It is hoped that this work will be used by some blast furnace operator in improvement of design, which will result in the practical returns of increased production and lower cost.

J. F. Agerter: I believe that anyone who has been connected with blast furnace operation for any length of time could not help but be interested in the paper

which has just been presented. That the size and shape of blast furnace salamanders should in general conform to some basic thermal laws, I have never questioned, but it has not been my privilege until now to see the results of the thermal flow demonstrated as well as Prof. Paschkis and Dr. Mirsepassi have done in this paper.

I have had, of course, no practical experience with underhearth cooling and it is quite probable that I never will have. The majority of the salamanders that I have seen have been tapped from all ceramic hearths. I have been of the opinion that, other things being equal, the size of the salamander in any given furnace was a function of three things: vis., the quality of the ceramics, the quality of workmanship by the masons, and the amount of wind blown per square foot of hearth area during the campaign of the furnace. I have witnessed an unaccountably large salamander in a furnace, and on the next campaign of the same furnace, a salamander which was unexpectedly small. We, of course, must expect some variation due to different conditions.

As an operator I have never been overly concerned about the size of the salamander as long as it stayed in the furnace until it was tapped. The authors have shown that the point where a breakout was most likely to occur was about the level of the original furnace bottom. The hearth breakouts that I have witnessed have all been about this level or somewhat above.

The authors have shown that about all that could be gained from underhearth cooling would be a reduction in the size of the salamander. Possibly there would be a reduction in the amount of refractory material in the hearth, but this would probably be offset by the cost of the cooling installation whatever medium was chosen as a coolant. Personally I would not want to venture using water as an underhearth cooling medium and I am unable to visualize a successful installation using air. To me there does not seem enough to be gained to encourage pioneering in this field.

I think the authors are to be congratulated on the very thorough manner in which they have investigated this subject and also on their excellent presentation of their findings.

C. M. Squarcy: The importance of proper hearth linings and proper hearth cooling cannot be over emphasized. A study of the contour lines of some of our furnace hearths that have been blown out show a remarkable similarity to the contour lines presented in this paper (Figures 34-38). During the last few years we have been tapping the salamanders of our furnaces and then inspecting and recording the salamander contour lines. Since the authors are not considering mechanical erosion or chemical corrosion the contours are very close. In addition the different sizes of furnaces and the tonnages on linings of the various furnaces would have some effect.

At the Inland Steel Co. only one furnace has been lined with carbon block. The carbon block constitutes the top courses of bottom blocks to a depth of 45 in. The furnace campaign is still in progress and over 3,000,000 net tons of iron produced. From the author's work we should expect a salamander penetration equal

Figure 34 — "B" Furnace lines — November 1950.

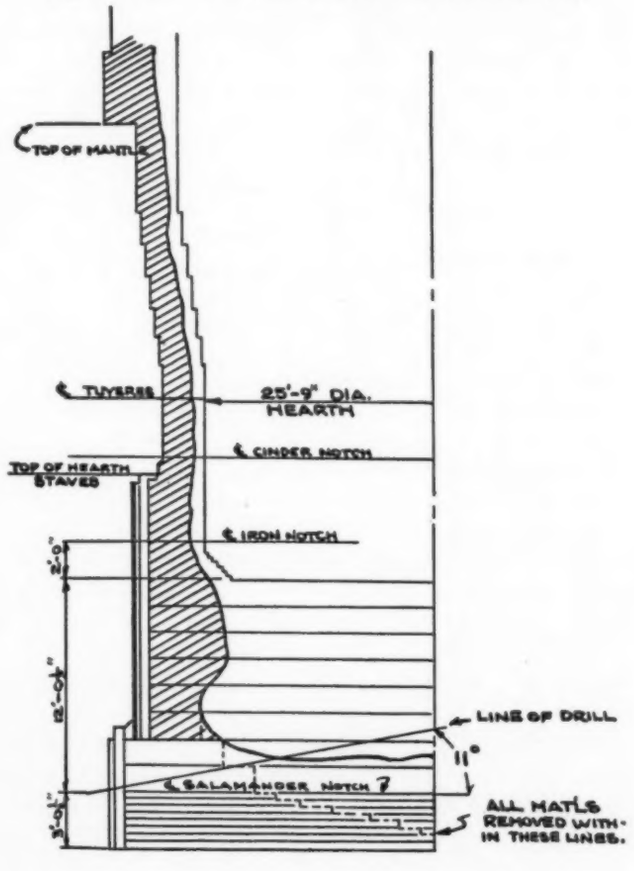
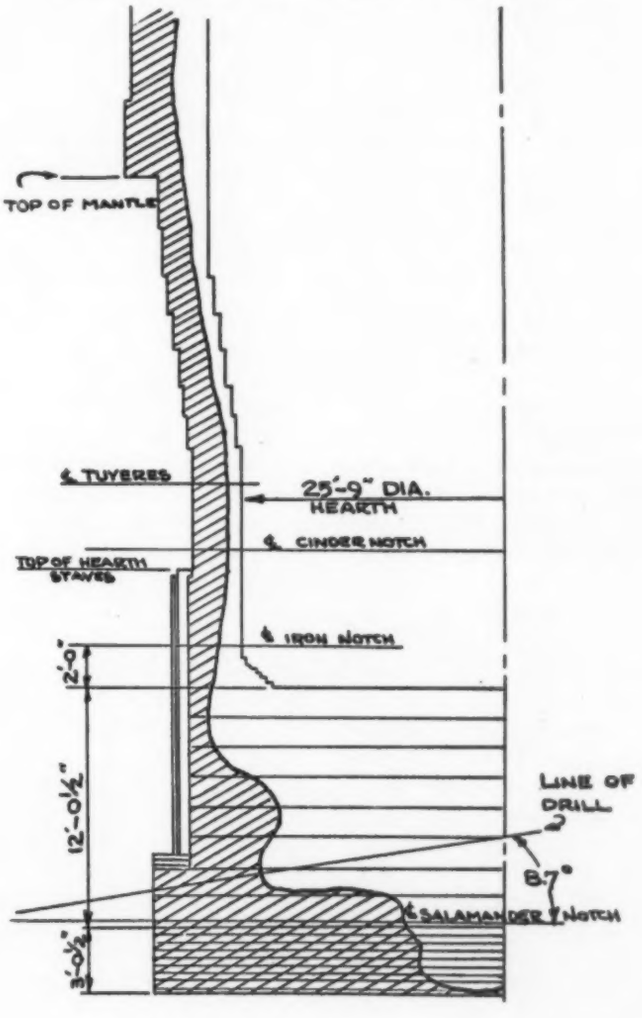


Figure 35 — No. 5 Furnace lines — December 1951.



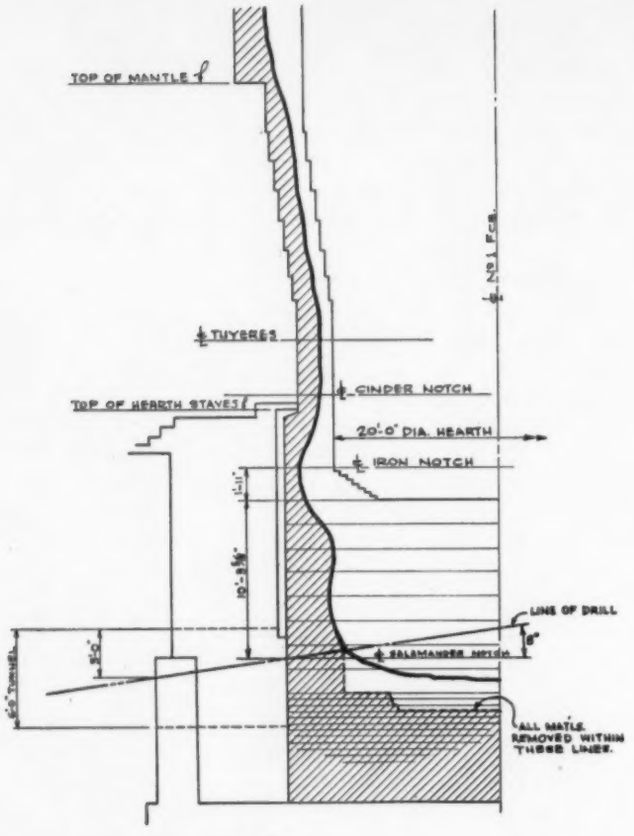


Figure 36 — No. 1 Furnace lines — July 1953.

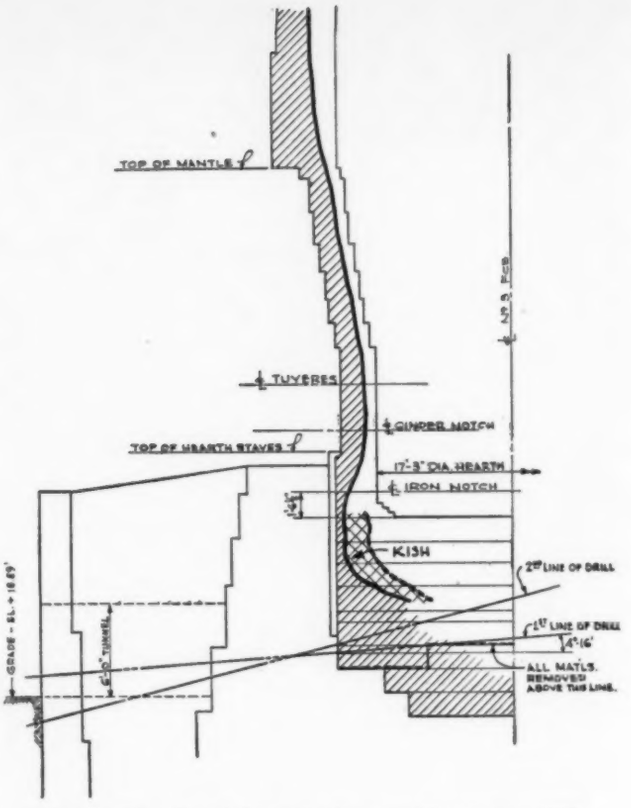


Figure 37 — No. 3 Furnace lines — November 1953.

to that of our ceramic lined furnaces. The contour lines however should be farther away from the side walls. The authors also state that with all carbon hearths it would not be necessary to provide underhearth cooling to prevent salamander penetration to a depth greater than 5.25 ft. From the above I would presume that the failure of the top 45 in. of carbon block to prevent salamander penetration would be due to failure of the ceramic lining supporting the carbon block. Premature failure of the carbon blocks could be due to mechanical failure of the ceramic lining beneath the carbon blocks.

As far as underhearth cooling is concerned, it does not have any effect on the contour lines of the salamander at the side walls where a breakout is more likely to occur. The use of underhearth cooling would represent a hazardous condition, to say the least, if mechanical erosion or chemical corrosion causes the hearth failure.

It would seem to be a question of whether the salamander in the furnace performs any function. It does represent a considerable quantity of heat and undoubtedly helps to smooth out irregular furnace operation of a short duration. However it has been our experience with new furnaces where there is no salamander that the furnaces respond more quickly to blast temperature changes, whereas an older furnace that goes cold needs a much larger heat input. It would seem to indicate that the salamander gives up some heat to a certain critical amount; if more heat is given up more drastic measures are necessary to bring the furnace back. This is usually a burden cut or the use of extra coke.

W. H. Collison: The authors have reported further on their investigations of a matter of concern not only in this country but abroad as well.

In attempting to evaluate this work, it should be

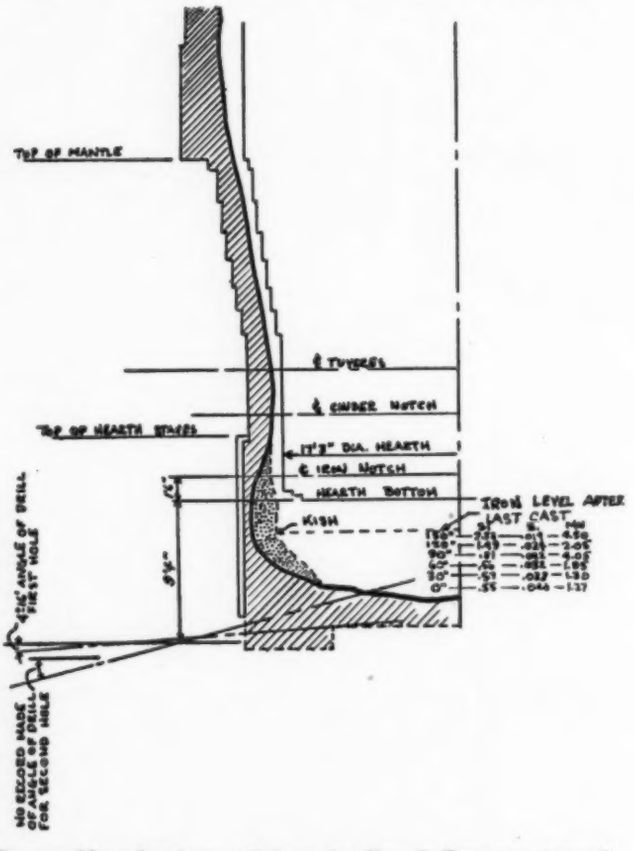


Figure 38 — Analysis of iron in No. 3 Furnace hearth.

noted that these investigations are based on thermal considerations only. Sound materials whose thermal properties are known, good workmanship and the absence of destructive chemical action over-riding the isotherms, are necessary if the conditions indicated are

to be obtained. It should be noted that the British consider the electrical analog computations for the same type of problem to be accurate within 10 C.

It is indicated with underhearth cooling we would have the safest furnace with the freezing isotherm farthest away, with a shallow salamander and with high rates of heat transfer. The work also indicates that with a material of high heat conductivity such as carbon and without underhearth cooling, the salamander will be more shallow than the 5t ft-3 in. depth with a ceramic bottom with underhearth cooling. To the operator who would tolerate such a salamander and who regards underhearth cooling with liquids, especialy water, with disfavor, this may indicate underhearth cooling is unnecessary.

Some of you know that underhearth cooling is in use at Dommarfvets in Sweden as reported by Christer Danielsson on furnaces of hearth bottom thickness of only 6 ft and hearth diameters of 14 ft-9 in. An oil circulating system is used on two furnaces, the oil in turn being cooled in water-cooled heat exchangers. Provision for pressure relief and rapid drawing of the system are provided. A third furnace at this plant is cooled by circulating air. These installations are reported to be operating satisfactorily.

The eight arrangements of carbon and refractory should provide sufficient information to select a design in this area.

We believe this report to be a worthwhile contribution to the fund of knowledge being accumulated toward the solving problems connected with the blast furnace hearth.

T. J. Wilde: Thermal aspects, as presented here, are certainly of great importance in considering design and materials for a blast furnace bottom. Until recently, little has been known on this subject and the authors are congratulated on their excellent coverage of the many phases included in this paper.

A logical interpretation of this work is to apply the results comparatively in selecting a bottom arrangement which thermally will provide the smallest salamander or molten iron penetration over prolonged periods.

With four or five hearths now operating abroad with some method of underhearth cooling, further interest has been shown in this country as evidenced by this investigation. The iron freezeline is obviously moved upward with the under cooling from a 10 or 11-ft depth to a 5-ft depth in the case of ceramic bottoms in the examples shown and from 4-ft depth to 2-ft for the all-carbon bottom. This is further exemplified in the "Summary of Calculations" (Table I) with the "Volume of Salamander" shown as 5,564 cu ft and 3,603 cu ft for ceramic bottoms without and with underhearth cooling respectively, and 2,266 and 1,767 cu ft for carbon.

These figures for carbon may cause some confusion for those who are acquainted with the mechanical breaking and loss of the center of older carbon bottoms of 45 in. thickness. Such findings in field examinations have been verified in the authors' first paper of two years ago and others, which show the possibility of molten iron penetration to below 45 in. thickness of a carbon bottom. This presentation now corroborates some five or six other papers, mostly originating in England, in placing the iron freezeline only a short way down with a full carbon bottom. A sufficient mass of material of higher conductivity must be used to accomplish this more desirable state of heat distribution.

Since the iron penetration depth, or "Volume of Salamander," is less with an adequate carbon bottom *without* underhearth cooling than the ceramic bottoms even *with* such cooling, this step of installing improved carbon bottoms is being taken at many locations in the United States today. Bottom erosion in the recent materials other than carbon are still reported to be progressive with time and tonnage, so that this improvement has been desirable to match the longer hearth life now possible with carbon hearth walls.

Such linings of present-day design are also "locked-in" by mechanical design through the use of round key rods placed into longitudinal half-round keyways across the vertical joints of the large bottom blocks, all surfaces now being accurately machined for face to face contact. Our carbon material for bottoms has the further advantage of heat conductivity and a shrinkage upon heating of less than one-tenth that of the carbon used in bottoms abroad. It is believed that these differences account for the mechanical inadequacies of deeper carbon bottoms in foreign installations where they have been lost from the central hearth.

When the next step of going to underhearth cooling is taken in this country, it should be pointed out that the bottom thickness might be reduced. The age-old practice of building heavy bottoms to accommodate salamander formations may no longer be necessary. It is implied here that the thinner the bottom, the higher the freezeline becomes with undercooling. This has certainly been in evidence, in effect, in actual experience with carbon hearth walls where two or three feet against cooling have remained essentially at their original thickness with iron penetration stopping near the hot face. To date this condition has been seen to still exist with tonnages up to 3,333,000 tons.

J. A. Pierce: The authors are to be complimented on their fine presentation of comprehensive calculations on a wide variety of constructions for blast furnace hearths. This is the type of paper which "points the way" and must necessarily be based on many assumptions if it is to accomplish its purpose of hurdling many years of cut and try field experience.

Hearth wall coolers have established themselves as standard equipment on a blast furnace since they successfully increase the thermal gradient between the refractory working face and the outside refractory surface thereby reducing the chance for breakouts in this area. The case for underhearth cooling is now presented, and on the basis of the calculations seems to hold much less interest for further limiting breakouts and for reduction of salamander volume even if satisfactory engineering can be accomplished.

Actually, in comparing carbon versus fire clay refractory constructions, including several interesting combinations, the thermal relationships at various hearth depths were pretty well known ahead of time. Aside from necessary assumptions, the calculations are primarily based on invariable physical constants for

thermal conductivity. In other words, it is absolutely certain that the thermal conductivity of carbon exceeds that for any type of fireclay brick. Nevertheless, this paper locates isothermal lines for various constructions, and these will undoubtedly be very interesting to individual engineers and operators who have special problems. Some interpolation may be possible in order to relate these data to actual furnace lining operating thicknesses.

One thing that should be said is that while the theoretical isotherms will remain in approximately the same location regardless of the type of fireclay brick chosen for the bottom, experience now confirms that the use of extra hard fired super-duty brick definitely results in smaller salamanders. The improved density and lower porosity have increased volume stability to the point where there is only about half the potential shrinkage of high-duty brick. Increased refractoriness is also a factor. With the super-duty material, we now hear of bottom wear of the order of five to six feet in comparison with figures twice that large in some instances with the regular high-duty blast furnace brick. A sufficient number of furnaces has now come off the line to give us the confidence that considerable improvement in blast furnace hearth service characteristics is available at nominal cost and without considering thermal conductivity characteristics.

G. L. French: This paper analyzes the theoretical results of underhearth cooling used with three types of hearth construction:

1. All ceramic.
2. Ceramic bottom—carbon sidewalls.
3. All carbon.

The following assumptions are made to provide a "base" for the study:

1. This is a purely thermal study, the effects of erosion or chemical action on the refractories are disregarded.
2. The study is a mathematical one using the heat and mass flow analyzer, an electric analog computer.
3. It is assumed that, at the time of blow-in, the hearth fills with liquid, stagnant iron in contact with the refractory faces of the original lines, at a temperature of 2700 F.
4. It is assumed that the 2100 F isotherm represents the limit of iron penetration, thus the final outline of the salamander.
5. All physical properties of the materials involved in the hearth construction are assumed to be constant, independent of temperature.
6. It is assumed that at some depth below the original hearth floor elevation, a constant temperature is maintained. The depth at which this temperature is maintained, in turn, influences the depth to which the salamander will penetrate.

To make the study of the effects of underhearth cooling, the level of cooling was selected so that after penetration the 2100 F isotherm intersected the vertical center line of the furnace at a depth of 7.0 ft below the iron notch. Since the iron notch was assumed to be 1 ft-9 in. above the level of the original hearth floor, the depth of salamander was then 5 ft-3 in. below the original floor.

The results of the study, based upon the above assumptions, indicate that the all-ceramic or ceramic bottom—carbon sidewall hearth would be penetrated to a depth of 5 ft-3 in. below the original floor if the underhearth cooling were located at a depth of 7.8 ft. Under the same conditions, i.e., the 7.8-ft. level cooled to 100 F, the carbon hearth will be penetrated to a depth of only about 2 ft-0 in. These theoretical results are borne out by our practical results with cooled sidewalls of carbon block set directly against the hearth staves.

The results also indicate that with an all-carbon hearth, "The salamander will not reach a depth of 5 ft-3 in., even if the underhearth cooling would be very far away or practically non-existent."

The above results are important, since they appear consistent with our practical experience. Conventional all-carbon hearth construction results in heat units being conducted from the iron through the carbon to the adjacent material, whatever it might be. If this material has lower conductivity than the carbon, the 2100 F isotherm moves downward through the depth of the carbon bottom until equilibrium is finally established. This might provide the explanation for loss of carbon bottoms set on ceramic sub-floors, which had been assumed to have been lost entirely by floating.

The study also includes results obtained by increasing thickness of the carbon sidewalls at the level of the ceramic hearths. As might be expected, the 2100 F isotherm is deflected upward through the carbon, as opposed to the normal course it would take through the all-ceramic hearth.

The paper also discusses various methods of underhearth cooling which might be practically applied. The authors recognize that both practical considerations of design, coupled with the reluctance of operators to install water cooling or even air cooling, will finally dictate what can be done. However, they offer the figures and calculations necessary to indicate several ways that results may be obtained.

Summarizing, the paper has pointed out three things very clearly:

1. All-carbon hearths will have less salamander penetration than any combination of ceramic and carbon, with equal cooling.
2. Underhearth cooling will not affect the frequency of sidewall breakouts, as far as a thermal study can show.
3. Underhearth cooling is feasible from a standpoint of thermal design.

Professor V. Paschkis: The present paper, together with the previous one completes perhaps the theoretical thermal studies for bottom of a 28-ft diam blast furnace. If the influence of furnace size is not important, one could direct attention to other aspects of the blast furnace. The furnace as unit has probably been considered from a metallurgical aspect and also in thermodynamic terms. But interesting information might be obtained by following the heat transfer to the charge. One can conceive a blast furnace as a heat exchanger, with the gas stream and the stream of ore and coke moving in opposite directions. A study based on this concept should be very revealing.

Preliminary Program

ASSOCIATION OF IRON AND STEEL ENGINEERS

1956 AISE CONVENTION

AND

IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO

September 25, 26, 27, 28

Tuesday, September 25

9:15 am — Business Meeting

9:30 am — Electrical Session

Electrical equipment for rod mills.
Speed regulation of hot strip finishing trains.
Electric drives of hot strip mill — reversing roughers with close coupled edgers.

9:30 am — Blast Furnace Session

Reducing delays during the blast furnace campaign through improvement of mechanical features.
Split wind blowing.
Air proportioning in blast furnaces.

2:00 pm — Mechanical Session

The design of mill buildings.
Treatment and reuse of mill scale wastes to conserve water and abate pollution.
Economics of low vs high purity oxygen applications in the steel industry.

2:00 pm — Combustion Session

The prevention of gas incidents.
Control of atmosphere generator.
Relative values of various gases for scarfing.

Wednesday, September 26

9:00 am — Electrical Session

Electrical maintenance at the Pueblo Plant of the Colorado Fuel & Iron Corp.
Protection of men working on overhead cranes.
Greater flexibility for wire drawing . . . individual generators and electric regulators provide higher speeds for multi-motor machines.

9:00 am — Combustion Session

Plate heat treating and normalizing.
Studies of surface stains on annealed cold rolled steel.
Modernization of wheel heating facilities, Johnstown Plant, Bethlehem Steel Co.

2:00 pm — Operating Practice Session

Nuclear applications in steel plants.
Pipe: manufacture and use.
Transportation control in steelmaking.

2:00 pm — Lubrication and Paint Session

Solvent degreasing — a valuable industrial cleaning process.
Evaluation and specification of paint for industrial use.
Use of silicones in the steel industry — lubricants and paints.

6:00 pm — Old Timers' Dinner

Thursday, September 27

9:00 am — Operating Practice Session

Economics and design of hot blast cupolas in connection with steel plants.
Maximum economical size of the top charge electric furnace.
Performance of hollow electrodes in steel furnaces.

9:00 am — Lubrication Session

NLGI Standards for greases.
High temperature steel mill greases.
Rust preventive compounds for steel mills.

7:00 pm — Formal Dinner and Dance.

Norman Lewis will give a humorous talk called "The Kick in Life."

Friday, September 28

9:00 am — Rolling Mill Session

Modernization of the Weirton strip mill.
Backup rolls and their contribution to gage variation.
Calmes process for making tubes.

9:00 am — Combustion Session

Open hearth control.
All-basic open hearth furnaces.
Open hearth precipitators.

2:00 pm — Electrical Session

Analytical and experimental investigations of cold reduction mills with automatic gage control.
Roughing motor inching drives.
Automatic gage control and production analysis on a "Z" mill.

2:00 pm — Operating Practice Session

Automation and its tooling and the concept used at Inland Steel Co.'s new rail joint line.
Electrical equipment for continuous annealing of silicon steel strip.
Edge position control.

IRON AND STEEL EXPOSITION

Nearly 200 suppliers of the iron and steel industry will display and demonstrate their products and services. Four complete halls containing more than 450 booths will be used by these companies to present their newest developments for steel industry application.

Plan now to attend!

EXPOSITION HOURS

Tuesday, September 25	**10:00 am — 10:00 pm**
Wednesday, September 26	**10:00 am — 10:00 pm**
Thursday, September 27	**10:00 am — 5:00 pm**
Friday, September 28	**10:00 am — 4:00 pm**

HOTEL ACCOMMODATIONS

Hotel reservations should be made direct to the hotel of your choice, giving time of arrival and type of accommodations desired. Reservations should state that they are for the AISE Convention. If they are unable to take care of you, they will forward your request to the Cleveland Convention Bureau, who will place you elsewhere.

REGISTRATION

Registration for both the Convention and Iron and Steel Exposition will be held in the main lobby of the Cleveland Public Auditorium.

TRANSPORTATION

For those not using trains or planes and not wishing to drive, arrangements have been made with the Greyhound Bus Co. to provide charter service for groups or companies.

Also, certain of their regular runs will be designated as the "Iron and Steel Exposition Excursion." Reduced rates will be in effect for this service.

Details and rates for both services can be obtained from your local Greyhound Agent.

SOCIAL FUNCTIONS

Social functions will take place at the Hotel Statler, which is the hotel headquarters for this convention. All other events will be held in the Cleveland Public Auditorium.

MISCELLANEOUS

No inspection trip is scheduled for this convention.

effect of a well-balanced *Safety Program* on the community

By JOHN J. APPLEYARD
District Director of Public Relations
United States Steel Corp.
Philadelphia, Pa.

▲ THE steel industry is one of the safest among all manufacturing industries, thanks in large measure to the efforts of iron and steel engineers who, over the years, have been building increasingly more safety protection into our plants and equipment. Steel ranks high among our safest industries for the further reason that "safety" is a watchword wherever we operate, and we have developed a corps of experts in this field second to none in the world.

The relationships between the steel industry and the communities in which it operates is dependent on a well-balanced safety program. In the opinion of most experts, safety is the cornerstone of good community relations. If a firm has a dynamic, well-balanced safety program, it will become known to its employees and neighbors in the plant community as a good place to work. This, of course, is a key factor in good public and industrial relations.

Some years ago I was a newspaperman in a small industrial city in the South. In and around the environs of the city were nearly a hundred furniture and textile plants, large and small. In those days, or at least on our paper, we had little direct contact with these plants, except on infrequent special features. Instead, our reporters had three key sources of news with which they were in constant touch—the courts, the police department and the hospitals. Leads obtained from these sources, more often than not, provided the biggest story every day.

Now, while negligence and carelessness may be called criminal, and in countless instances were responsible for charges on the police blotter, our most consistent source of news on my newspaper—the source we could most always depend upon for a juicy story for page one —was the accident ward of the local hospital. Here were brought the broken, mangled bodies of traffic victims, and here were treated the injuries of those men and women who were hurt, sometimes even crippled, in accidents in our industrial plants.

Mind you, only the most serious cases ever reached the accident room of the hospital. We had no way of knowing how many lost-time accidents were treated in the plant dispensary, and sent home. We do know that five private ambulances in this small city averaged as many as eight calls apiece every 24 hours. It was a lucrative business. And for awhile, once we started systematically to tap this source, it was also a lucrative fountainhead of news.

But, all things are relative, and in the newspaper business something that becomes commonplace loses its value as news. In time, so repetitive were the incidents of industrial accidents, they lost their value as news items, compared to the more dramatic cases of multiple highway injuries, or the tangled, bloody wreck of an automobile that had met an irresistible object. The result was that, before too long, the average industrial accident was no more important than to warrant a paragraph on an inside page.

It may seem strange, especially in view of the importance newspapers attach to industrial accidents today, that such incidents could be so lightly dismissed. In fact, sometimes we wish the press would ignore our accidents today as we did 20 years ago in that southern city. Although we were too blind to see it then, the accident rate in industrial plants in our city was so high as to have a tremendously important impact upon public opinion. The public was not shocked—and perhaps it should have been—but quite quickly and naturally a general impression grew in the public mind that industrial employment generally was unsafe. It is simple to guess the kind of industrial and public relation problems such a reputation created.

There is a further facet of this story. On the basis of long experience in the development of safety education and practice within industrial plants, our failure to create safety-consciousness on the job tends to leave a vacuum or unawareness in the thinking of the individual during the 16 hours a day when he is among his neighbors in the community. There is not the slightest doubt today, that, if well established, carefully engineered, conscientiously-pursued safety programs had existed in our industrial plants in that town, accidents in the home and on the highways could have been cut in half. Carelessness is a habit, a state of mind, just as safety is a way of life.

In recent years, safety has become a fetish in that southern industrial city and its manufacturing plants, just as it has in the steel industry and throughout our

Presented at Philadelphia-Regional Safety and Fire Conference and Exhibition March 7 and 8, 1956 . . . . this meeting is sponsored by a group of societies including the Philadelphia Section of the Association of Iron and Steel Engineers.

national life. We have made tremendous progress in the development of safety-consciousness and safety engineering, and continue to improve this vital facet of modern industrial, economic and social life every day; as well we should, because it is linked so closely to those humanities and values for which all of us have an increasing appreciation.

Today, the pendulum of newspaper attention to industrial accidents has swung in the other direction. The man who loses a finger, breaks an arm or suffers severe burns in our plant becomes news to the plant town paper. True, we would rather not receive such publicity by association; but the fact that we do is a left-handed compliment to our emphasis upon safety. Our plants are expected to be safe. Accidents are the exception, rather than the rule.

In this connection, speaking as both a former newspaperman and as a public relations representative of a steel company, let me suggest that we are far better off when, in the event of a serious accident, we make a practice of promptly releasing all pertinent details to the press, even volunteering it in some instances. It is always possible to indicate that a complete investigation has been made or is in process, which of itself indicates the importance we attach to the personal safety of our employees. But equally important, the practice of revealing the real facts and extent of injuries will frequently prevent misinformation from building such incidents out of proportion. It will preclude once and for all any suspicion that the company has something to hide, or that it is attempting to divert attention from a bad situation.

Much of the credit for the progress of safety as an important factor in our national life can be attributed to the management of American industry in general and the steel industry in particular. Probably the first great step taken by large industry toward wide safety-mindedness in our national manufacturing community was taken in 1913 when the National Safety Council was organized. Here in one organization was pooled the experience of leaders in the safety movement, made available for the use of all business, large and small, as well as the general public.

Again, in this milestone of safety, it was a steel group —the Association of Iron and Steel Engineers—which took the lead in extending this service to America. It was the engineers who formed the National Safety Council as an outgrowth of their own safety committee. From this early step have come the studies, surveys, statistics and programs which have spread the gospel of safety from industry to the home, highway and community. Those who are members of the AISE can be gratified that the National Safety Council is the child of your own blood, and has since gone out into the world to gain an enviable reputation as a force for the protection of every man, woman and child in America. Ask the average person what pops into his mind when he hears the name, and he will tell you that it is the statistical forecast or record of highway accidents, or the radio and television reminder that "the life you save may be your own." The AISE may have conceived the infant, but today it belongs to the people.

In much the same way, those programs for the promotion of safety we develop within plants have a way of becoming community property; and with the increasing public awareness of the importance attached to safety, they become a source of community pride. Ask the average visitor who has toured a plant what things impressed him most; and he will tell you that among the first things he noticed was the attention given to safety, both in practice and by printed reminder. But even if you do not ask him, in a large percentage of instances the average visitor to a steel or other modern industrial plant is so impressed by the emphasis upon safety, it will become one of the first things he recalls as he tells his friends about his visit. It is that kind of impression, even if it is unconsciously received, which contributes to the stature of the plant in the broad area of public opinion.

We have a saying in United States Steel's public relations organization that, "no matter how well geared we may be to tell our story, it is far more important that we have a good story to tell." I can think of no area where this applies more directly than in our safety performance, for if our mills are unsafe, if we have a poor safety record, no amount of publicity on any subject can hide or erase this fact from public knowledge, or minimize its effect upon public opinion.

But safety is something we should talk about, not only in our daily contacts with the men in our plants, but in the community. Most of us do. This does not mean publication of safety records, which of course has an indirect favorable influence upon public thinking, but more specifically to the practice of making our experience available to others. Safety-mindedness is something that can be shared again and again, and in the process becomes not only self-renewing to the end that there is always enough to go around, but tends to improve its source at the same time.

To this end, our own interests measured in terms of the profit dollar if you will, but more appropriately in terms of the welfare of our employees, their families, their neighbors and the community will be best served by the broadest possible dissemination of all of the intelligence we have developed on this subject. No opportunity should be missed, for example, to instill safety and proven safe practice into various school programs, particularly in shops and vocational schools. Much of the experience gained through the years is invaluable to both public and volunteer fire departments. Police departments, faced with some increasingly complex problems of which safety is a vital factor, can undoubtedly profit from many aspects of industrial safety experience. We are constantly developing new methods, new practices, new engineering designs which decrease personal risk, and new techniques of teaching these principles to employees. And since there is no competitive advantage in such knowledge which compares to its broadest possible use to protect human safety wherever it may be, it is important that such findings be shared, as widely and as promptly as they can be. Information of this type can be developed for public consumption through regular news channels, or exchanged for the experience of others through the medium of industrial safety forums.

There is no area of interest between industry and the community where reciprocity can be so useful as in the development of the common safety objective. For

example, in many communities the local Chapter of the American Red Cross provides instructors for training industrial employees in water safety and first aid. These employees, in turn, train others within their own plant. But what is of equal importance is that the opportunity is frequently available for the company to make trained personnel available for the instruction of others, in other plants or community organizations.

Now, obviously, we are interested in something that is far greater than safety at the working place. Accidents that occur on the highway or in the home can be just as damaging, can as easily deprive us of skilled personnel, or can as readily create individual and family hardships as mishaps which occur in the plant. How do we protect our employees and ourselves during the 16 hours a day when our people are off the job? Creation of the awareness of safety on the job is a beginning, of course. Experience has demonstrated that most employees become so safety-conscious that it is a topic of conversation at home and abroad. This again is the sharing of a way of life, and we know that this kind of thought transference is effective. But is it enough?

Many companies do not think so. One which comes most easily to my mind is General Motors. Some years ago, impressed by a number of booklets General Motors distributed to its employees on publication racks placed at check-in points throughout their plants we asked to be placed on their mailing list to receive these publications as they were put out. Ever since that time hardly a week has gone by but that we have received at least one, and frequently several GM employee publications. They cover a multitude of subjects up to, or down to and including, how to plant and grow flowers. They are interestingly written, cleverly illustrated, and free.

Over a period of time, several of these booklets have been addressed to the subjects of safety—safety on the job, the care of safety equipment and clothing, color as a safety factor, rules for greater highway safety, safety in the home, and so on. Even General Motors would probably not venture to guess what the approximate readership of these publications may be. Suffice it to say that they print far more copies than they have employees, and it is a safe assumption the average copy is read by more than one member of the employee's family.

While impelled to be a little magnanimous in this reference to one of our good customers, one should be hardly surprised to learn that United States Steel has had a similar effective off-the-job safety educational program for its employees for many years. Since the slogan "Safety First" originated in the Steel Corporation, it is scarcely unusual that many of the advances in employee safety education stem from our own constant efforts in this area.

Whether we take a page from the book of General Motors, or whether we insert a page on safety in our employee publications that are read in the home, there is a great deal we can do to share the principles of safety with our neighbors. Fortunately, this is a relatively common practice among the companies in industry. Some pursue the practice further than others, some are better equipped than others to carry out missionary programs of this character. But in whatever measure we serve the community interest by the development of a well-balanced safety program within our plants, and project this interest into the community at large, in such measure are we compensated in return with growing respect and confidence of our neighbors which are so important to the creation of the climate in which we operate.

"The Effect of a Well-Balanced Safety Program on the Community"—how can it be measured? So far as we know, no way has ever been found, nor is it likely to be found in any degree of accuracy. However, the effect is a substantial one. It is reflected in our industrial relations, in our public relations, in the attitudes of our employees toward their jobs, in the attitudes of the public toward our plants. It is the combination of these attitudes which creates the climate in which we do business. It affects productivity very importantly. Strange as it may seem, or possibly it is not so strange, our general relationships in a myriad of matters are sensitive to public opinion, to the atmosphere we have helped to create by our own conduct, our own attitudes toward our employees and our neighbors.

That industrial safety programs have a firm place in the considerations of the community, and exercise an influence in the public welfare, is amply demonstrated by the fact that the Greater Philadelphia Chamber of Commerce is a principal sponsor of this conference. In our scheme of things, Chambers of Commerce have become one of the most effective avenues of communication between business, industry and the general public. It is gratifying that, throughout the country, increasing attention is being given to the subject of safety through public forums of these organizations. The record shows conclusively that there is a marked increase in the exchange of safety information through these channels. The public welfare and the relationships between industry and public opinion cannot help but benefit mutually from the thoughtful pursuit of this important common interest.

However, since we in industry have a major interest in increased safety consciousness that is both humanitarian and self-serving, no opportunity should be overlooked which enables us either to contribute our best experience to such forums of exchange, or to benefit from them. In some communities it would be entirely appropriate and highly beneficial to the common interest for industrial members of these organizations to assume leadership in the development of such opportunities for the exchange of ideas. In all cases, we owe it to ourselves, our employees, their families and the public to expose every facet of safety promotion to the broadest possible audience. It is entirely fitting that we lend the fullest cooperation to any joint undertaking within the community which has as its objective the enhancement of personal and public safety.

There are many ways in which we in industry, as individual companies, can contribute to a greater public awareness of safety. First of all, we can tell our own safety story in news releases, photographs, booklets and speeches for distribution within our own plant communities. Since the public generally, and many special groups in particular, are becoming more safety minded, there is a constantly improving market for this kind of material. In passing, we can all give a vote of thanks to the automobile manufacturers for the new

emphasis on built-in safety in 1956. This one development has done more to dramatize safety-consciousness to the general public than anything that has happened in the last 10 years. But this is just a beginning. All of us must be constantly searching for similar means, not only to build safety into our plants and products, or to instill it into the thinking of our employees; but to discover those effective devices which will sell safety to everyone. Giving substance to the principles of safety as a mode of living is a continuing responsibility we can never put aside.

Speaking of the distribution of booklets on phases of our own company safety programs, an undertaking in this field by United States Steel Corp. is a case in point. Some few years ago, our safety engineers developed a program known as "Single Objective Safety." As a result of its application in our plants over a period of the first three years, there was a reduction of 35 per cent in the frequency rate of lost-time accidents and 45 per cent in the frequency rate of all accidents. Did our safety people clasp this program to their chests, like a tightly held trade secret? Of course not! Through booklets and addresses before other groups, they made it available to thousands of firms, and associations. The same policy was followed when our company developed another program known as the "Three C's of Safety." And this policy will continue to prevail as we gain new and effective experience.

Or, take another illustration typical of the safety policies of large companies. During the construction of the Fairless Works at Morrisville, some 200 prime contractors and a total of over 4000 subcontractors were employed on the project. On every U. S. Steel project, the company engineer has personally assumed responsibility, and works with the contractor to make sure that every job is performed in accordance with our own safety standards. With 11,000 men working on the project site, regardless of the fact that they were not directly employed by United States Steel, poor safety performance could have created a bad impression by association which would have been especially harmful to our reputation as we were moving into this new community. Through careful supervision by our own safety engineers, the performance on this project was 60 per cent below the national average for similar projects. Needless to say, this was an excellent performance and a good start toward an even more impressive record. Since the plant went into production, the care exercised at the outset of our program has paid off in dividends of good public opinion. Moreover, it served as an introduction to carefully supervised safety protection which could not help but make a lasting impression upon a large segment of the construction industry. We are particularly proud today that the Fairless Works holds one of the best records in one of the nation's top four safest industries.

We might add a personal note, to say that our association with this project as public relations representative was the first opportunity we had had in our tenure with United States Steel to observe safety engineering and a carefully planned safety program in action. It made such an impression that we now find ourselves thinking in terms of safety in everything we do, at home and away. We can give personal testimony that what we do within our plants has a broader impact in our personal and community life.

We know of no yardstick with which we can measure our accomplishments in the successful promotion of safety in the community, at least to the degree that in-plant programs influence local safety statistics. We are readily aware, however, that growing interest in safe practices in home and community life reflect the emphasis we place upon safety in American industry. We realize, too, only full well, that continued and increasing liaison on this subject is a requirement of our times and a responsibility we cannot afford to neglect. We all wish we could say that our accomplishments up to now could be described as "a job well done." But the fact of the matter is, all we can say—but with justifiable pride —is that it is "a job well begun."

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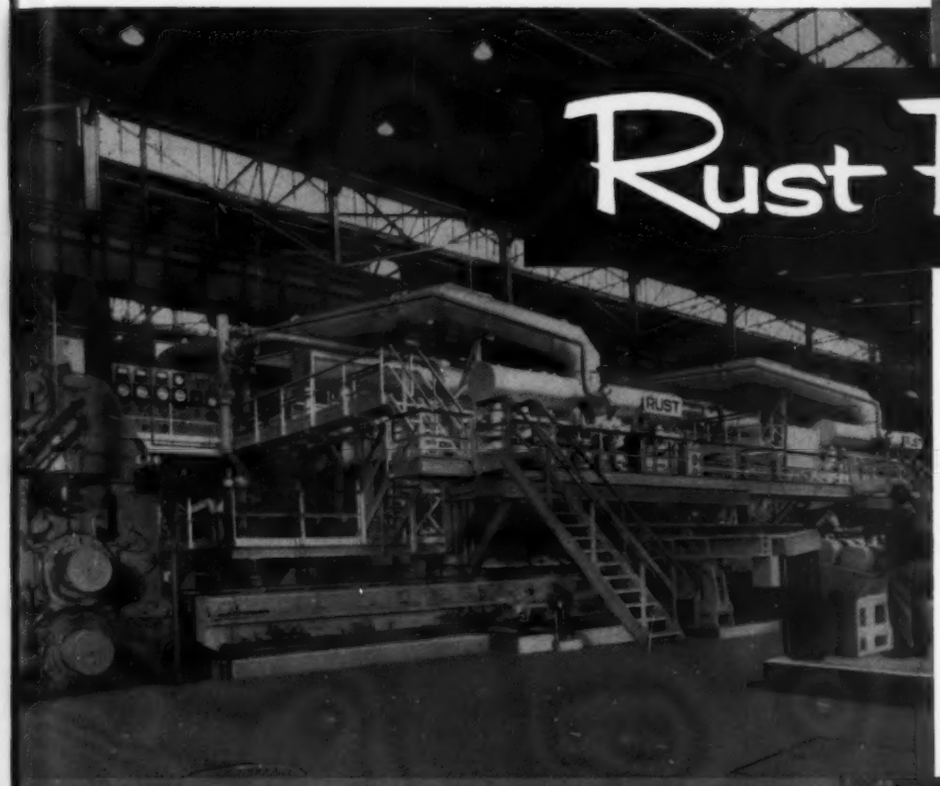

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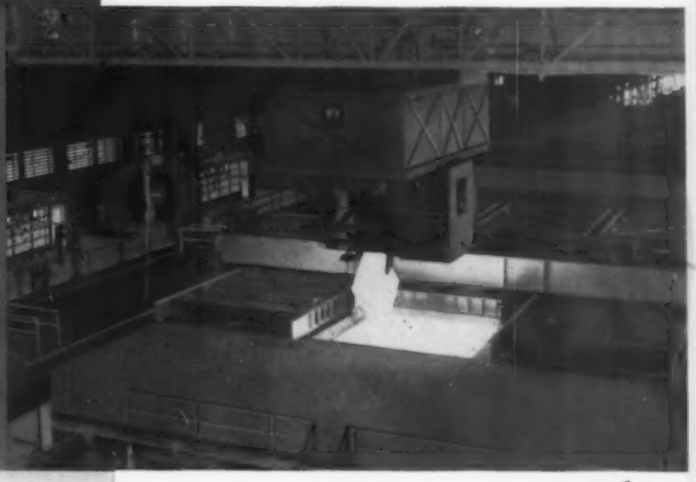

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E. W. Bliss Company has acquired controlling interest in The Matteson Equipment Company, Inc., Poland, Ohio.

Matteson has designed and supervised construction of continuous annealing and pickling lines, galvanizing equipment, hot dip tinning equipment and other types of steel mill auxiliary equipment both here and abroad.

Until now, the manufacture of Matteson-designed products was handled by independent sub-contractors. As a subsidiary of E. W. Bliss however, the manufacturing facilities of the entire Bliss organization will be available to Matteson, thus making possible a closer degree of quality control and improved delivery schedules.

Likewise, the addition of Matteson designed equipment will supplement the wide range of rolling mill machinery now built by Bliss.

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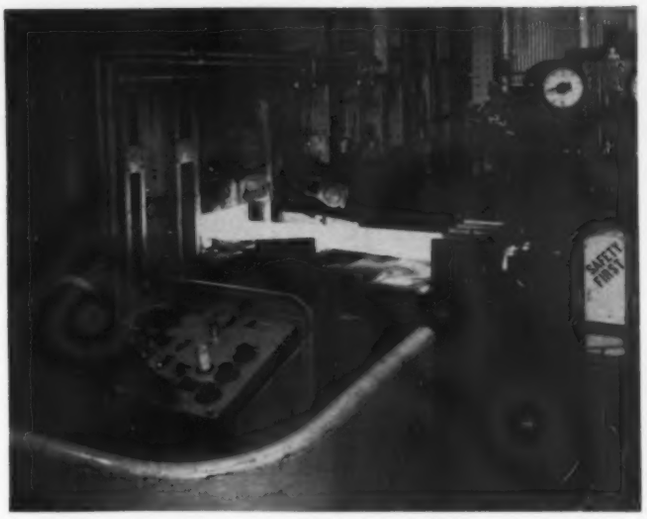

Figure 1 — The 34-ft long, 3¼-in. sq billets wind up as 9000-ft of steel rod weighing about 1200 lb.

American Steel and Wire Puts New Cleveland Rod Mill in Operation

▲ AT American Steel & Wire Division's Cuyahoga Works crews are "shaking-down" what is believed to be the world's fastest rod mill, producing four strands at more than mile-a-minute speeds. Before the year is out, this mill will reach its annual capacity rate of production of 450,000 tons. Known as No. 1 rod mill, it will eventually replace the yearly 360,000-ton output of No. 2 and 4 rod mills placed in operation there in 1916.

The new facility includes a combination rod mill, billet storage area and rod storage area. The mill consists of 25 roll stands and is capable of rolling all sizes of rods from a minimum of commercial No. 5 gage (0.218 in.) up to 1½ in. in diameter. All of the smaller sizes up through 9/16 in. diam are rolled four strand; while sizes over that figure are run either double or single strand up through the maximum 1½ in.

All sizes of rod are rolled from a standard size 3¼ x 3¼ x 34-ft steel billet weighing 1200 lb. The billets as received by rail are stored in outside billet storage racks serviced by overhead traveling cranes. These cranes unload incoming billets, stock them in proper racks according to analysis, and as needed remove them from the racks and place them on a mechanical "billet unscrambler." This device automatically unpiles batches of billets and positions them in a single layer ready for delivery to the heating furnace run-in table.

The billet heating furnace is capable of heating 100 tons of billets per hour. The furnace is of two-zone construction with a hearth area 38 ft wide and 70 ft long and has side charge and discharge openings. The furnace hearth is a combination of water cooled and refractory skids. The fuel used can be natural gas, coke oven gas or fuel oil as desired, and the furnace is complete with refractory recuperator which provides 700 F preheated air. The brick lined steel stack carrying the furnace's products of combustion is nearly seven ft in diam and 150 ft high.

Complete control of temperature, fuel-air ratio and furnace pressure is available to handle this first step in rod rolling. The billets are charged four at one time from the furnace run-in table. There are approximately 256 billets in the furnace being heated at any one time. Time-wise, a single billet remains in the furnace for about one and a half hours in order to bring it to about 2150 F from its original cold state.

The billets are discharged one at a time from the furnace by means of a push out unit. This consists of a pair of electrically driven pinch rollers which propel a push out bar, which in turn contacts the end of the billets and shoves it from the furnace into the first stand of the mill. As the billet leaves the furnace, a pair of motor driven pinch rollers aid in feeding the billet into the mill.

Since four billets are rolled simultaneously, it is necessary for the operator at the entry end of the mill to direct the billet being pushed out of the furnace into the pass which is empty. This is done by a four-line billet switch that is capable of keeping all of the active pass lines continuously supplied with hot steel without any intervals of inactivity. The entire mechanism is operated hydraulically and controlled by an operator at a nearby control desk who can see the operations at all times. He also signals the push out operator when another billet is required.

For rolling sizes 3/8 in. and under, there are 23 rolling stands in tandem, starting with five 18-in. diam roughing stands; four 16 and six 13-in. intermediate stands; and eight 12-in. finishing stands. The final product

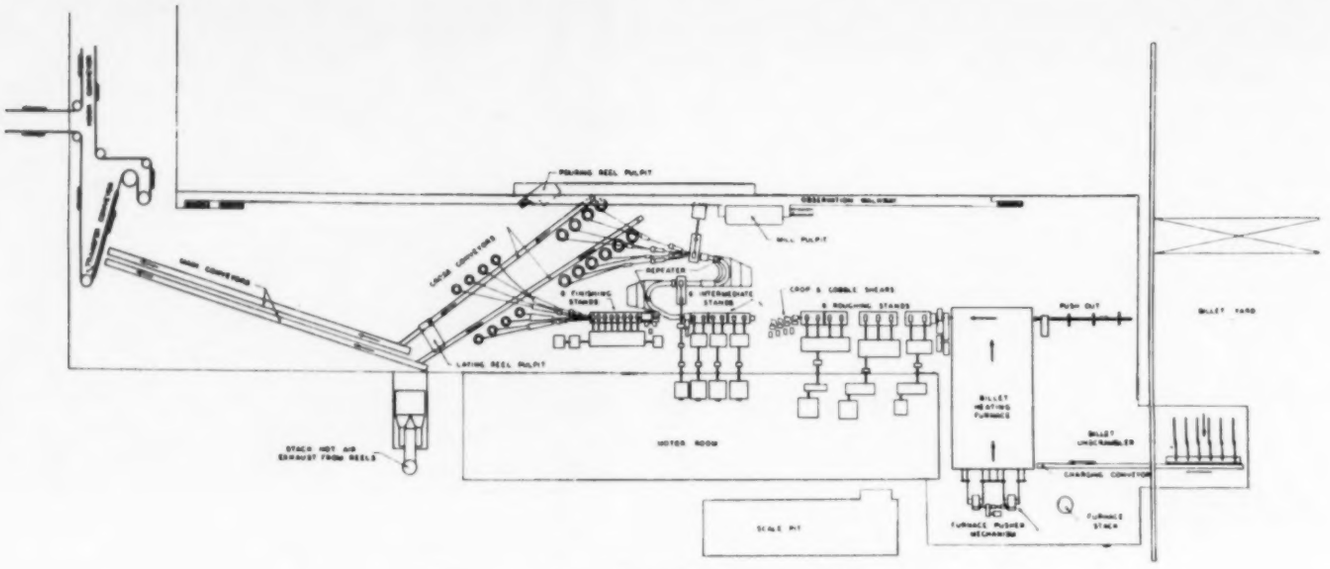

Figure 2 — No. 1 Rod Mill Cuyahoga Works.

from the finishing pass is coiled on laying type reels and discharged onto a series of flat conveyors which in turn transfers the coils to a hook conveyor for delivery to the rod inspection and loading area.

For sizes larger than 3/8 in., the same roughing and intermediate stands are used, but the rods from No. 15 stand are diverted through repeaters into two 13-in. looping stands for finishing and then the rods are delivered to pouring type reels. These reels discharge the coils onto the same system of conveyors as mentioned above.

All of the roll stands of the mill are of cast steel and equipped with screws operated through worm gears for accuracy of top roll adjustments. The bottom rolls are adjustable to maintain correct pass elevation. The stands are equipped with oil film bearings to maintain accuracy of sections being rolled with a minimum of adjustment.

Ten motors (totalling about 13,500 hp) drive these 25 stands through pinion housings and gearing—all fully enclosed in oil tight casing. Oil is continuously supplied from central lubricating oil systems located below the mill's operating floor. The different kinds of oil maintained at the proper operating temperatures by heating and cooling mechanisms are constantly being filtered and cleaned of all water and impurities.

As the finished rods are delivered by the last finishing stand they are conveyed in pipes to the proper reel. Each of these delivery pipes contains a series of water spray nozzles for reducing the temperature of the rods as much as desired prior to their entering the reels. Directly following the spray section, each pipe contains a water eliminating section which prevents cooling water from getting into the reels. The water in the pipes is automatically tripped on and off as rod enters or leaves the pipe.

Because of the high delivery speed of the smaller sized rods, the laying reels are equipped with forced air cooling which furnishes a high volume of cool air down through the coils. Each reel has a separate blower and again, no human hands are needed to automatically shut off the air just prior to the coil being discharged onto the drag conveyor. The amount of air to be delivered to the individual reel can be varied to control the desired rate of cooling for different analyses of rods. Each reel is driven by a separate adjustable speed motor interlocked with the speed of the last finishing stand to insure correct speed synchronization at all times between the reel and the finishing stand.

The pouring reels which receive and coil the rods from the two looping stands are of the latest design and produce coils with outside diameters of 40 in. Provision has been made for increasing this to 48 in. if desired. The reels, which are also air cooled, are driven through separate adjustable speed motors and the stripping and coil discharge mechanisms are electrically operated with all motors fully synchronized and interlocked. Dynamic braking is used to stop the reels prior to discharging of finished coils.

Through use of various stands available, the mill will produce both fine and coarse rods in bundles up to 1200 lb in contrast to former bundles of 300 to 600 lb. This speedy production unit plus increased bundle size will in turn enable customers of American Steel & Wire to achieve maximum efficiency.

Many customers in the bolt, screw and other fastener industries, welding spring, and automotive parts business and material handling equipment capable of handling rod bundles in excess of 1000 lb. The larger bundles lend themselves to the continuous operation of present-day manufacturing equipment.

The rolling operation is controlled from one main air-conditioned operating pulpit. From here the operator can at all times see each stand of the mill and can adjust the speed of each stand as conditions require. In addition to the main operating pulpit, there is also a control desk for the furnace discharge operator; a control desk for crop and cobble shears; and separate pulpits for laying and pouring reels. The operators in these pulpits can control the rotary dividing shears and switches, the reel pipe sprays, the reel drives, strippers, pushoffs, fans, coil conveyor and hook carrier.

Design and erection was under supervision of Floyd A. Garman, chief engineer, American Steel and Wire Div. Mill was built by Morgan Construction Co., Worcester, Mass.

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Kaiser Expansion to Increase Capacity 40 Per Cent

▲ A $113,000,000 expansion program at Kaiser Steel Corp.'s Fontana, Calif., steel mill will begin at once, which will increase production of steel ingots and finished steel by 40 per cent. Production of finished steel products will be increased from 1,084,000 tons to 1,528,000 tons per year with the addition of the new facilities. This expansion will place in operation more steel producing and finishing facilities than were built into the original Fontana plant during the entire war period, 1942 to 1945.

Construction is scheduled for completion in 1958.

Major units to be installed include an oxygen steelmaking process plant with two 65-ton vessels to produce steel ingots, a slabbing mill for initial rolling of the ingots, a second electrolytic tinplate line, and various major changes and additions to increase output in the hot strip mill, plate mill, and tin mill.

The oxygen steelmaking process plant will be the first plant of its kind in the west. Output from this facility will augment the steel production of the nine open hearth furnaces now in operation.

This current expansion program, together with other projects initiated since the company's last previous financing in October, 1953, will constitute an addition of more than $140,000,000 of capital assets for Kaiser Steel Corp, by the end of 1958.

Figure 1 — Diagram shows location of proposed new facilities at Kaiser Fontana plant. Facilities to be added are those shown in the dotted areas.

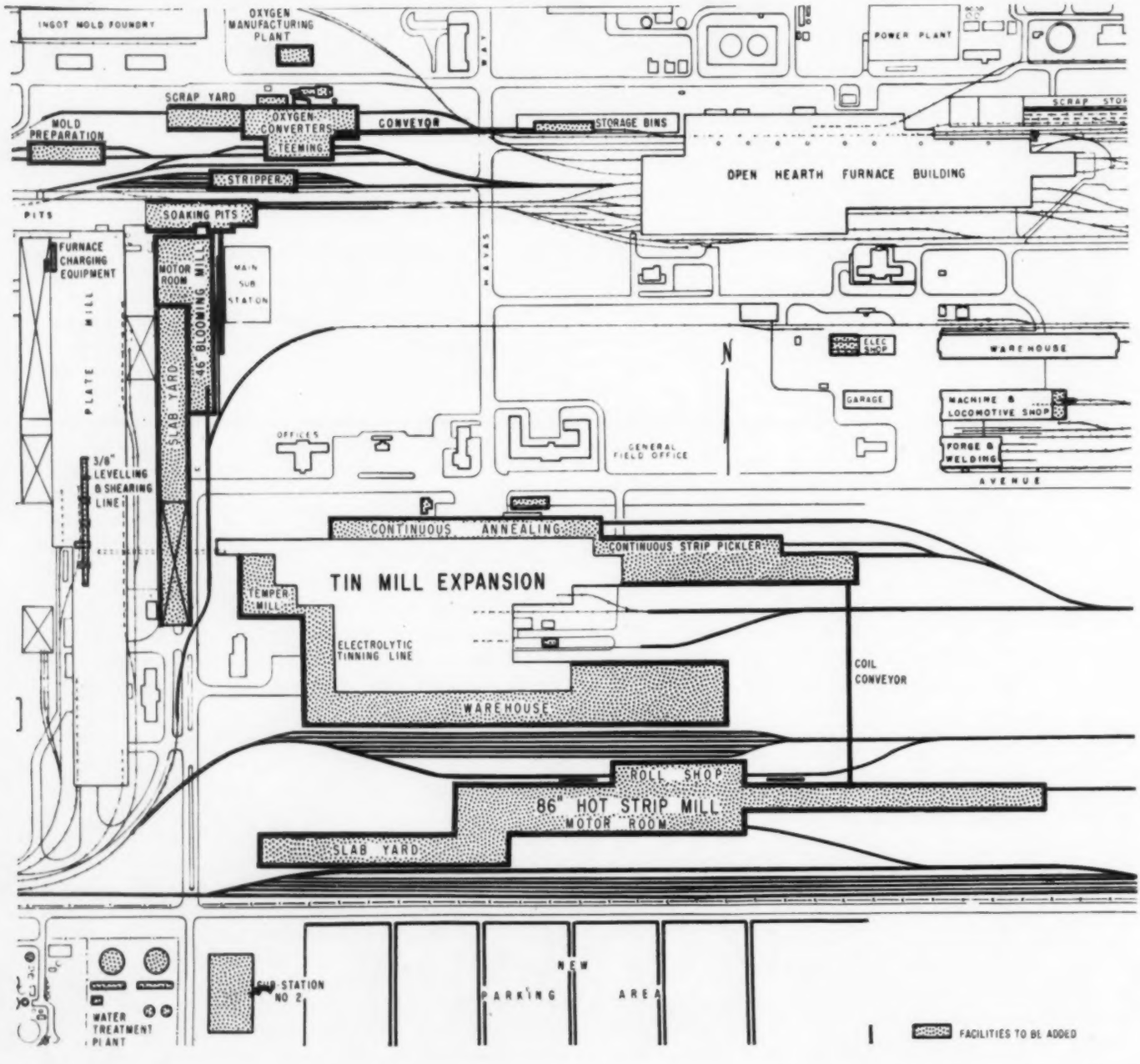

Figure 2 — Kaiser Steel Corp. will begin immediate construction on a $113,000,000 expansion of steel producing and finishing facilities at its Fontana, California, plant shown here. Located 45 miles east of Los Angeles, the Fontana plant has three blast furnaces, nine open hearth furnaces, and nine separate rolling mills. Plant property covers 1800 acres.

To finance this expansion, the company is arranging to borrow $100,000,000 from institutional investors. Financial arrangements are being handled by First Boston Corp.

Design and construction of the new facilities is being handled by Kaiser Engineers of Oakland. It is estimated construction will be completed in about two years, although individual facilities will go into operation as they are completed.

An important factor in this expansion is Kaiser Steel's unusually strong position with respect to raw materials—iron ore, coal and limestone. At the company-owned Eagle Mountain, Calif., iron ore mine, construction of a second iron ore beneficiation plant is proceeding on schedule. This plant will further up-grade the high quality ore to 60 per cent iron. These extensive iron ore deposits are located only 164 miles from the steel mill.

As part of the current expansion a new coal drying plant will be installed at the company-owned coal mines at Sunnyside, Utah, where high grade coal is processed through a washery before shipment to the steel mill.

In early 1957, deliveries of limestone are scheduled to begin arriving at the plant from the company's recently acquired Cushenbury deposit in Lucerne Valley, Calif., 75 miles from Fontana.

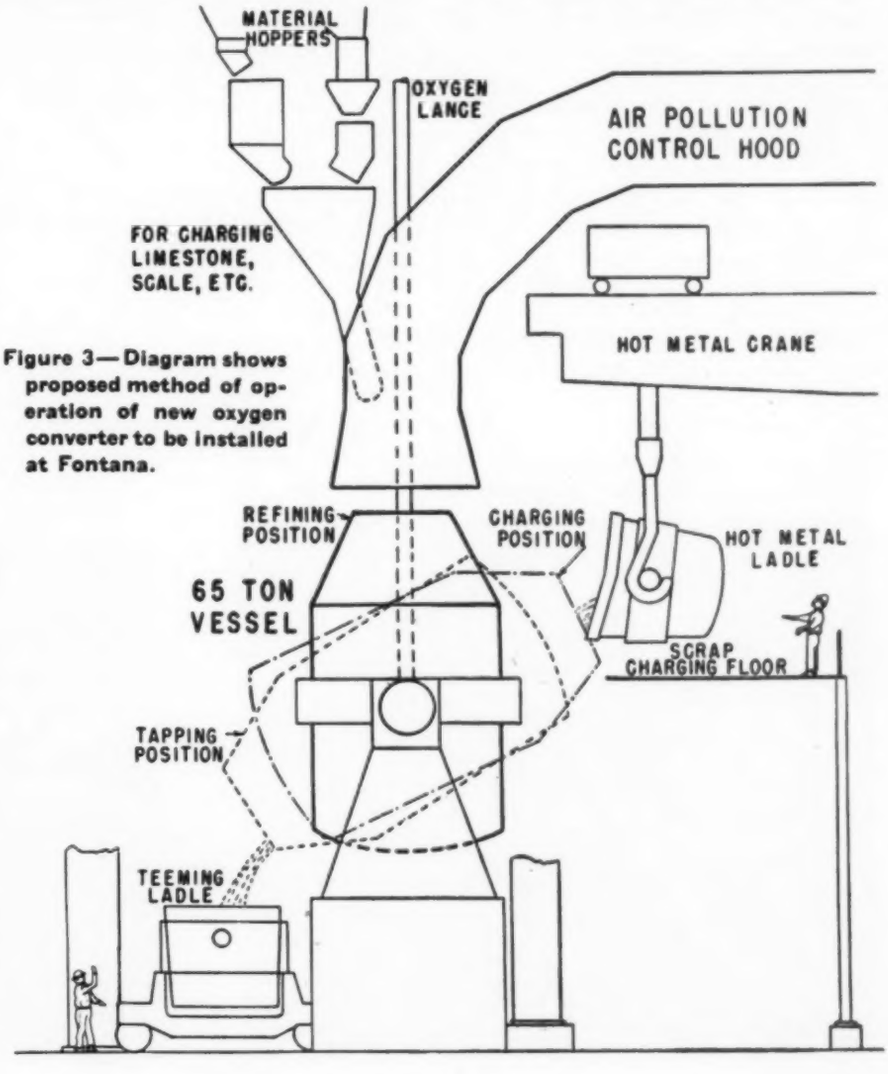

Figure 3 — Diagram shows proposed method of operation of new oxygen converter to be installed at Fontana.

L&N OPENS NEW INSTRUMENT PLANT

▲ A new instrument manufacturing plant of the Leeds & Northrup Co. was officially dedicated on May 11. This plant is located in the suburban town of North Wales, Pa.

This facility manufactures automatic industrial instruments such as speedomax recorders and recorder-controllers, metermax combustion control, and L&N load-frequency control. Elwood H. Rogge, assistant production manager, is local manager at North Wales.

The building is a single-story structure with some mezzanine areas; total floor space is over six acres; one of the largest plants in the world devoted to this kind of product. Located on a tract of 129 acres, the land and buildings cost about $4,000,000; contents and inventory about $7,000,000. This total of $11,000,000 will provide work for about 1300 people, or about $8400 per worker in plant alone. The establishment was designed by Giffels & Vallet Inc., L. Rossetti, of Detroit, and built by Baton Construction Corp., Philadelphia.

The plant provides for comfortable, pleasant working conditions as well as efficient production. It is ventilated by air ducts and fans which can distribute as much as 500,000 cfm. At air temperature of 72 F, this comes to 18.7 tons per minute. This air is filtered, and in winter the return air is mixed with fresh filtered air, heated and circulated. In summer no return air is used; 100 per cent outside air is filtered and circulated. Windows are of glare-reducing glass; walls and roof are insulated, and the roof is also water-cooled in summer. Departments which have special problems in heating, ventilating or air conditioning have independent systems. Machines which could cause severe vibration are on floors insulated from the rest of the building. It should never be necessary to open a window for comfort; summer or winter.

Because of the wide variety of products, mass-production techniques are seldom used, but great emphasis is placed on proper sequence and arrangement of operations, efficient tooling and other measures to assure economy of production and maintenance of quality. Inspection operations are performed "in the flow of production" wherever possible.

Figure 1 — Plant has over six acres under one roof, sits in a 129-acre tract and will employ about 1300 people.

Figure 2 — Drill press section, Leeds & Northrup Co.'s manufacturing plant for automatic instruments and controls at North Wales, Pa.

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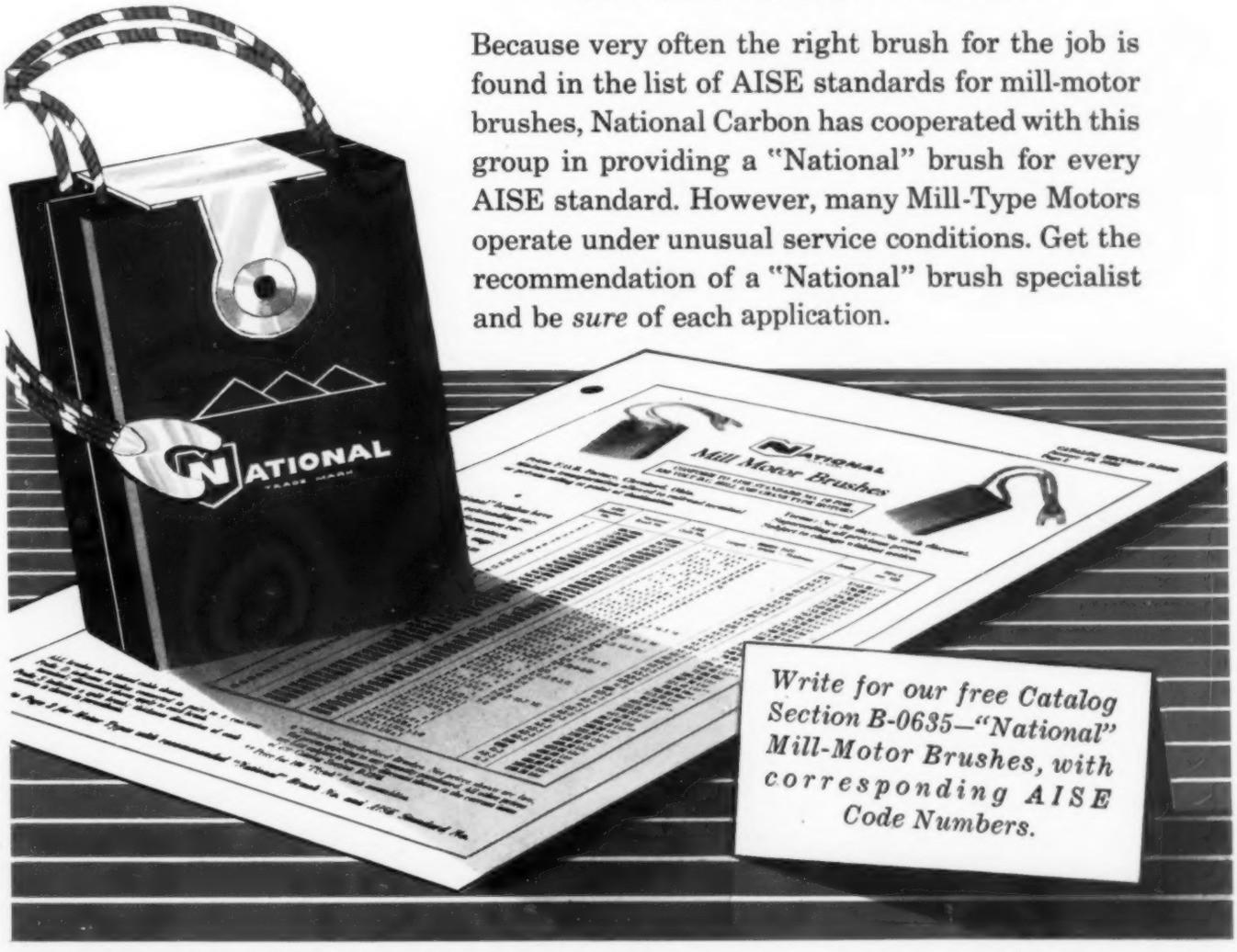
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Mill Motor Brushes
Write for our free Catalog Section B-0635—"National" Mill-Motor Brushes, with corresponding AISE Code Numbers.

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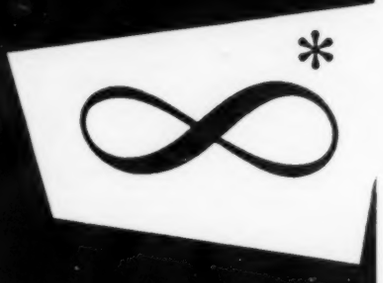

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Bring your problems in metal finishing processes to the one company experienced in the brushing of metals.

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OSBORN PIONEER IN THE BRUSHING OF METALS

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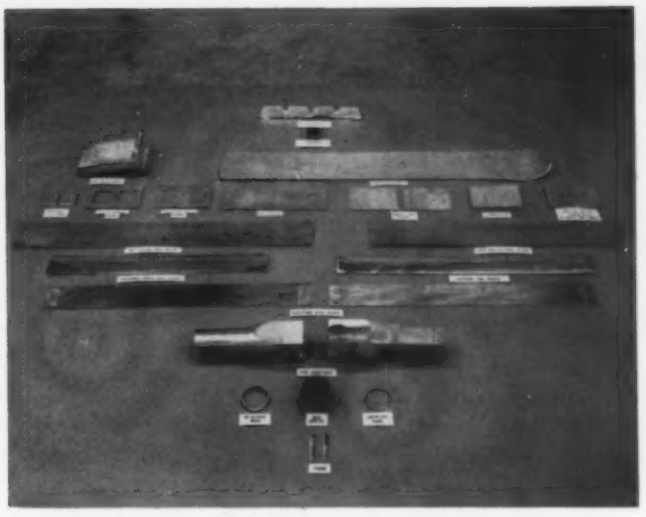


Figure 1 (above) — Materials for use in fabrication of nuclear reactor fuel elements are hot rolled on the small combination mill at right, or the larger mill in center. Prior to rolling process, materials are heated in salt bath unit at left, or in resistance furnace in right background, depending on nature of metal in use.

Figure 2 (right) — This view of the components of a nuclear reactor fuel element illustrates the complex melting, alloying, forging, rolling, machining and other processes involved in nuclear production. Parts are from a fuel element type now being made in the Babcock & Wilcox Nuclear Facilities Plant, Lynchburg, Va., for the U. S. Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho.

B&W STARTS OPERATING IN FIRST PRIVATELY BUILT ATOMIC PRODUCTS PLANT

▲ WHAT was once a quiet farming tract six miles east of Lynchburg, Va., became an atomic age landmark on May 17 as the Babcock & Wilcox Co. Nuclear Facilities plant began production on the site. The plant is the first major facility in the nation erected entirely at private expense to manufacture and test nuclear fuel elements and related products for peacetime use.

Set in the center of 520 acres along a bend of the James River, the new plant is divided into two spheres of activity—a nuclear fuel element fabrication unit, and an experimental unit where reactor core components will be studied and tested.

The fabrication building has complete metal casting, rolling, welding and machining equipment to turn out flat-plate type fuel elements. Production has already begun here on a year's supply of fuel elements for the U. S. Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho. Delivery of the first 35 assemblies under this contract is scheduled for August of this year.

Babcock & Wilcox also has contracted to design, fabricate, erect and test the nation's first privately owned nuclear steam generator for the Consolidated Edison Co. of New York. Production of fuel elements for this reactor will begin as soon as final design details have been completed.

Initial operations in the new plant's experimental facility will be devoted to determining the nuclear characteristics of the Consolidated Edison reactor design. The first core assembly made to one-quarter scale, will be tested at a power level which will seldom exceed the output of an ordinary flashlight battery. Thorium, which is converted to new reactor fuel as fissioning takes place, will be a component of fuel elements employed in tests here, representing the first nuclear use of thorium by private industry.

The experimental facility, which is 1,200 yards from the fabrication building, is slated for completion in the near future. A reinforced concrete bay nearly three stories high, and with walls running to a thickness of three feet, forms the test chamber for critical assemblies.

While early activities at the plant involve existing contracts, the entire unit has been designed to manufacture and test a broad range of present and future reactor and fuel element types.

In planning the fabrication plant, provisions were made to add the facilities necessary to make pin, rod and cylindrical-type fuel elements, as well as the flat-plate types now in process.

The new plant reflects the company's continuing policy to develop and manufacture steam generation equipment which makes use of every available fuel, including nuclear materials.

Recently the U. S. Atomic Energy Commission selected the company to design, fabricate and operate a liquid metal fuel reactor experiment. Contract negotiations are now under way.

Babcock & Wilcox has also signed an agreement with Florida Power & Light Co., Florida Power Corp. and Tampa Electric Co. to develop, design and construct a large nuclear power reactor for central location within the service area of the three companies.

The new Lynchburg facilities will

figure heavily in the completion of most of these contracts.

The company also is studying the feasibility of homogeneous reactors with the Nuclear Power Group, and is a member of Atomic Power Development Associates and the Power Reactor Development Co.

While a majority of the processes and machines in use at the Babcock & Wilcox Co's. new Nuclear Facilities plant are familiar to industry, fuel element production requires a number of unusual techniques and modifications of standard equipment.

The plant's fabrication building and tools have been designed mainly to produce flat-plate type fuel elements by metal casting, rolling, welding and machining, width and length of these plates, and arrangement of the plates to form an element, will be determined by the demands of the various types of reactors B&W contracts to build.

ROLLING MILL

The heart of the manufacturing area is a Farrell-Birmingham 2-high-4-high combination reversible rolling mill. To accommodate a variety of fuel element designs in the future, it is arranged for maximum flexibility of operation.

Driven by two 50-hp, d-c motors, the mill utilizes 21 x 22-in. backup rolls for hot rolling, and 6½ x 22-in. cold work rolls backed up by 21 x 22-in. rolls. Rolling speed can be controlled from 0 to 216 fpm, and rolling direction can be reversed instantly. The mill has Timken roller bearings with pressurized lubrication. Maximum separating force is 1,500,000 lb. Pratt & Whitney pressure blocks are used in development work to minimize the possibility of exceeding the maximum allowable pressure.

The mill screwdown system consists of a dual setup with a declutching arrangement. High speed screws are driven by two 3-hp motors, and can be run at 4½ in. per min. The low speed screwdown is powered by two 10-hp motors, and operates at 0.109 in. per min. In the roll drive arrangement, a double pinion permits driving either the backup rolls or the work rolls when operating as a 4-high mill.

Associated with the Farrel-Birmingham unit is a Stanat 2-high and 4-high combination mill. This unit, however, is driven by an a-c motor, and only the backup rolls may be operated. Roll size is 1½ and 5 in. x 8 in. Maximum 2-high roll opening is 3¼ in., with adjustment by hand wheel. Speed control is provided by a manual gear shift which permits speeds of 30, 60, 110 and 185 fpm. This mill is also reversible.

Hot rolling, although possible on either mill, is concentrated on the Farrel-Birmingham unit. Material is heated to rolling temperature in either the box furnace or the salt bath. Although this mill has the capacity for specialized handling equipment, material will generally be handled manually. Material is hot rolled, using intermediate reheats, to the desired thickness, and is then cold rolled either on the small Stanat mill or on the Farrel-Birmingham mill after a roll change.

Forging operations are used to break down 6-in. diam arc melted ingots to 1-in. slabs for subsequent hot rolling. Materials are heated in either the salt bath or box furnace, and forged on a 6 mph impacter, with intermediate reheats as required.

Built by the Chambersburg Engineering Co., the impacter has a capacity of 6,000 ft-lb per blow. It is air-operated, but can also be steam powered.

Work is positioned between the dies by means of a guide roller, and all the energy of the blow is imparted directly to the work. In addition, the impacter is vibration-free. Each blow is controlled by the operator through movement of a valve device.

In the event it becomes necessary, the impacter may also be used with forming dies for small parts production.

ARC MELTING

Material which has a high melting point and is readily contaminated by crucible components is melted by a process which utilizes the material itself as an electrode source.

Proposed electrodes consist of compacted sponge zirconium and alloying materials. An arc is struck with an electrode in the bottom of a water-cooled copper mold, and the power input is adjusted to maintain a constant arc as the ingot builds up and the electrode melts away.

Melted in an atmosphere of argon-helium mixture, the electrode forms a 4-in. diam ingot. In turn, this ingot is used as the electrode for the remelt to produce a 6-in. diam ingot for further processing.

A vacuum arc furnace built by the National Research Corp. is employed in the arc melting process. The furnace has an electrode tower which houses the electrode on initial charging. During the remelt operation, the tower is removed. Guide rolls, electric contact rolls and the electrode drive mechanism are housed in a bell or center section. A speed variator, actuated by power fluctuations during the melting, controls the drive mechanism. During startup and shutdown, the operator can stabilize the arc by means of an override mechanism.

Sealed by gaskets into the bottom of the bell section is a water-cooled copper mold. This arrangement permits circulation of cooling water at high velocity to solidify the ingot quickly. The bottom of the mold is insulated from the sides to insure that power flows from the electrode through the ingot into the bottom contact, thereby minimizing the possibility of arcing to the mold side walls.

The furnace has a vacuum system of 100 cfm capacity, which is utilized for initial pump down. Normally operations are carried out in a helium-argon atmosphere, at a controlled pressure for minimum glow discharge. Pressure is regulated by a special valve. Three 1450 amp welding rectifiers, which can be controlled individually, make up the power supply.

INDUCTION MELTING

For production of certain fuel element alloys, induction melting and casting is employed. The process, which may be conducted in a vacuum, an inert atmosphere or in air, is centered in an 8 x 6 x 6-ft furnace made by the National Research Corp.

Although induction melting normally produces vigorous stirring due to the type of heat used, mechanical stirring has been found necessary to insure good homogeneity when alloys of extreme density differences are processed in graphite crucibles.

The furnace has a crucible capacity equivalent to 100 lb of steel. It is evacuated by an NRC Model 100-S rotary gas ballast mechanical pump, and an NRC B-6 booster pump. Power is supplied from a motor-generator set rated at 100 kw. Water circulating through copper coils provides cooling for the stainless steel shell.

Here's a drum that can't be beat!

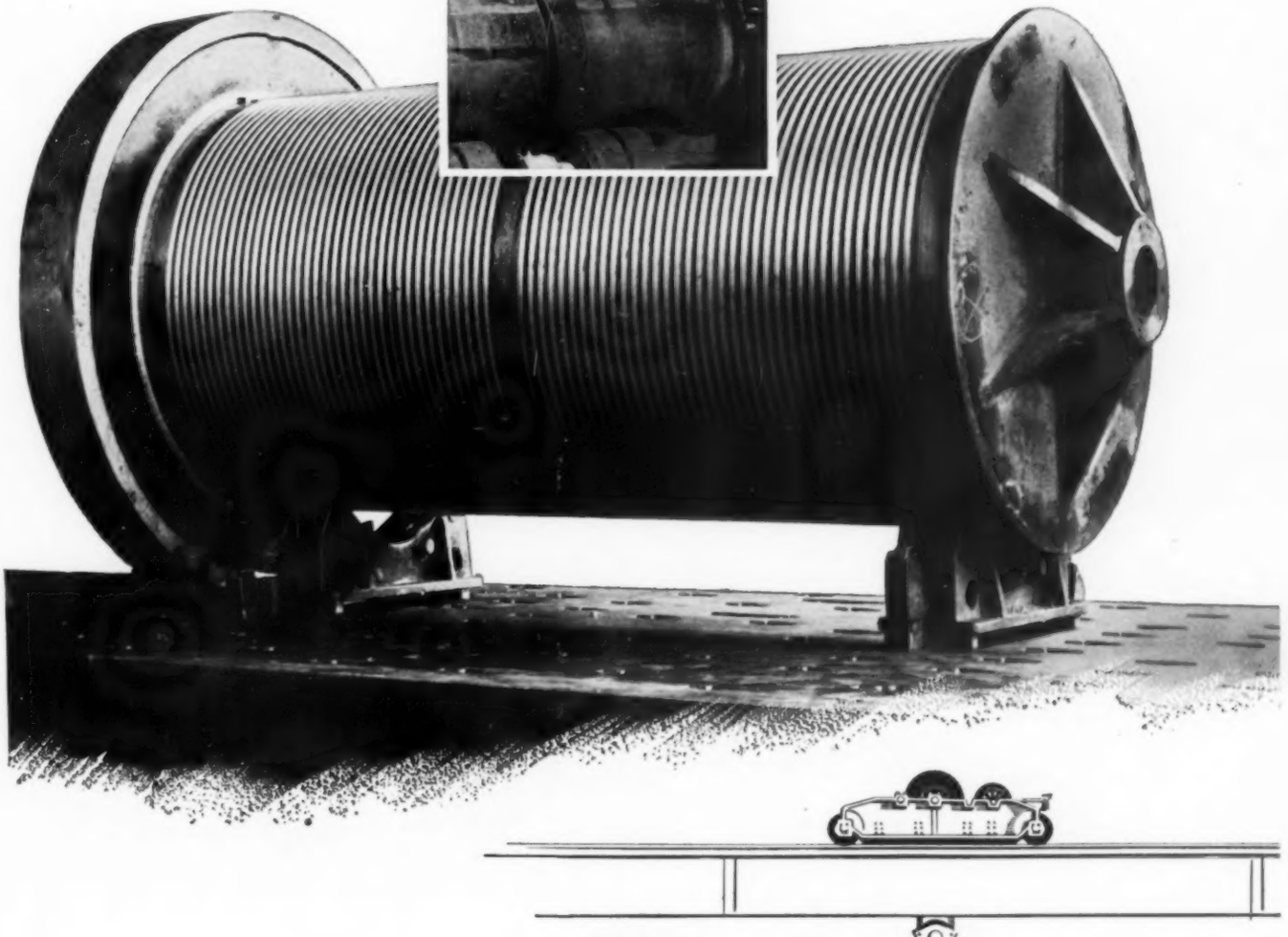
• *Fabricated drums* in Morgan cranes are structurally stronger than cast drums . . . yet they weigh less.

Automatic welding of Morgan drums with the world's largest continuous welding machine assures uniform, sound joints and seams.

Crane girders, too, are welded automatically, making them stronger and lighter. Morgan welders are qualified in accordance with A.S.M.E. and A.W.S. codes.

Performance records prove conclusively that Morgan cranes are the best in the business . . . cost less to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!

Automatic welding speeds up to 120" per minute are achieved on Morgan's continuous welder. Perfect welding penetration assures uniform, strong welds.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE
MORGAN
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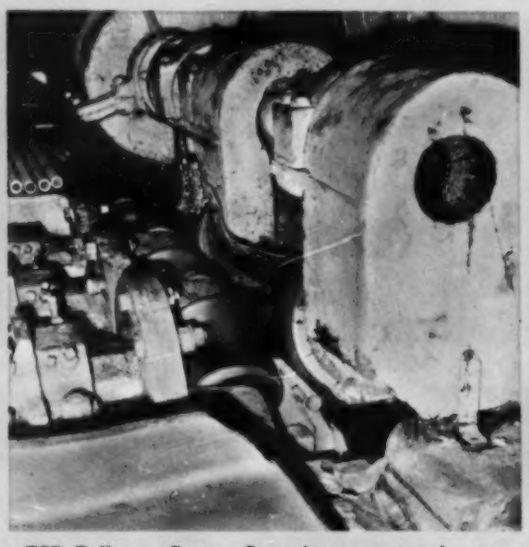
TSP DELIVERS DOUBLE SAVINGS

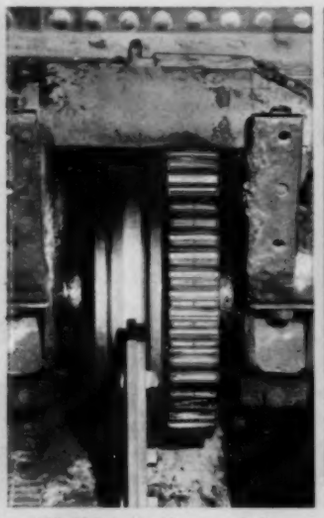
TSP Sheave Wheels still in service have already delivered 36 times the life of competitive sheaves, resulting in tremendous dollar savings.

TSP Sheave Wheels have increased cable life 8 to 12 times. These cables running on competitive sheaves wore out every month. Dollar savings alone are outstanding.

SP Shaft Pinion, Mating Gear, Intermediate Pinion, Axle Gear, Axle and Track Wheel on Charging Car. Competitive parts formerly used required replacement of one or more items every few months. TSP parts have been in continuous service for 5 years, showing practically no wear.

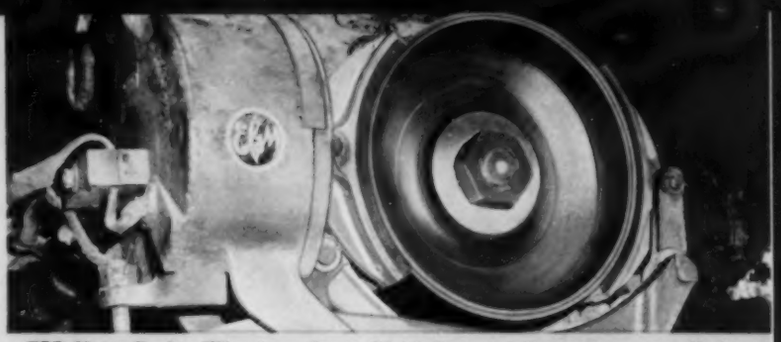


TSP Rolls on Sutton Straighteners give longer life and are used exclusively by Laclede Steel.

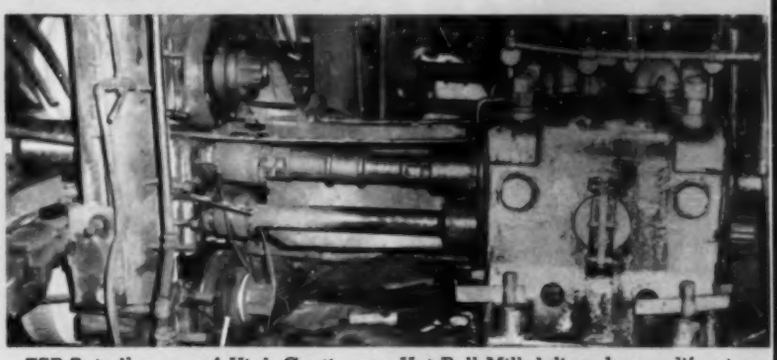


TSP Wheels, Gears, Axles, showing practically no wear after years of service.

TSP Screw-down Screw on Ingot Mold Stripper Crane outlasts competitive screws many times.



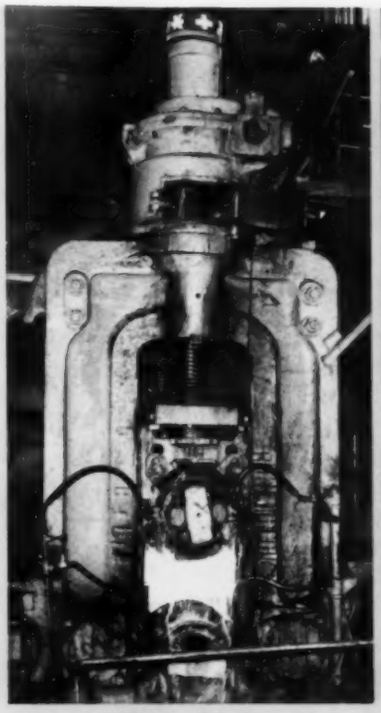
TSP Hoist Brake Wheel on Ingot Mold Stripper Crane was installed in 1946, shows hardly any wear. Competitive wheels formerly used lasted only a few months. TSP wheels now used exclusively. Brake linings are also lasting 2 to 3 times longer.



TSP Spindles on a 4-High Continuous Hot Roll Mill deliver longer life at a much lower cost than competitive spindles formerly used.

SUCCESS STORIES

COMPLIMENTS OF LACLEDE STEEL



TSP SCREW-down Screws and Nuts on 35" Blooming Mill replaced original competitive screws and nuts. Since replacement only TSP screws and nuts have been used.

TSP Herringbone Pinions on Bar Mill give many times the life of competitive pinions.

"Tool Steel Process" products are hardened by our special process. The life hard surface to the full depth of permissible wear gives maximum life. The core refined for toughness and ductility gives maximum strength.

You receive an absolutely positive written guarantee that TSP products will give a longer life in the same service than any other product. Write today for Bulletins.

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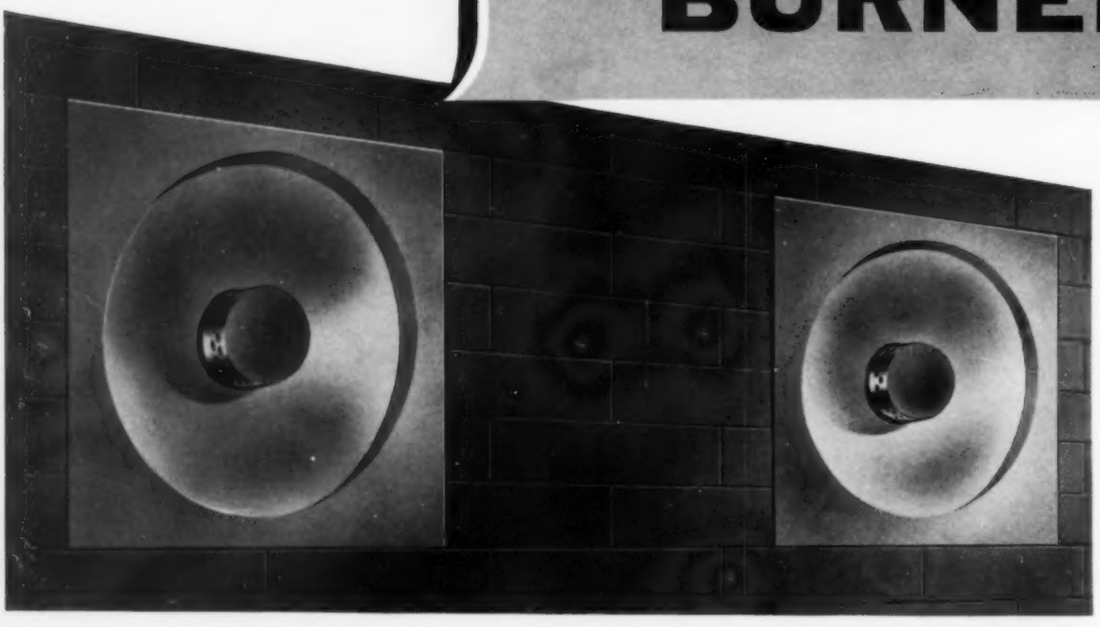
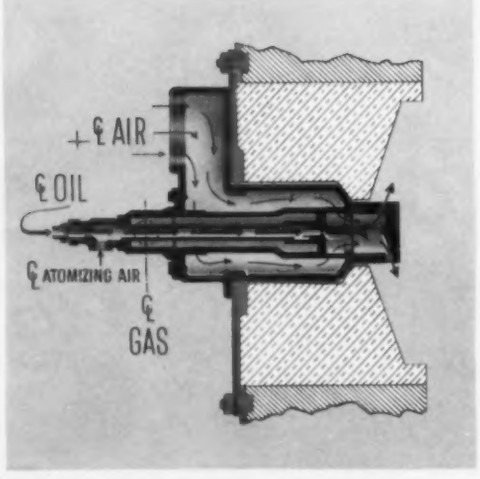
for intense concentration of heat . . .

The BLOOM HTR BURNER



The Bloom HTR Burner provides identical operation on either gas or oil.

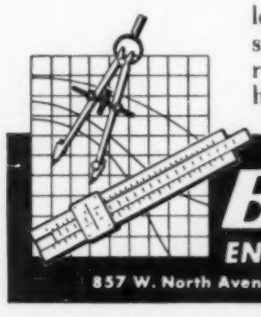


PATENT PENDING

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.



BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

High Temperature Alloy Increases Furnace Life

Figure 1 — A 25-12 cast alloy tube which failed after 10 months of operation is being pointed out. Directly in front is an NA22H cast alloy tube removed after 64 months of operation for general furnace overhaul. The tubes were both operated at approximately 1925 F in the same position in a continuous annealing furnace.

▲ A new high temperature alloy, NA22H, product of the National Alloy Division of Blaw-Knox Co., has established a new standard of performance in radiant tubes for continuous annealing furnaces. Proof of the performance has been more than seven years in the making.

Faced with the production losses and maintenance costs involved in periodically replacing "W" type radiant tubes in their continuous annealing furnace, one company manufacturing "furniture" quality continuous weld carbon pipe began experimenting with NA22H tubes as well as other alloys. With this new alloy they hoped to increase tube life, and thus reduce downtime and maintenance costs.

Past experience on the several furnaces into which 22H tubes were to be installed demonstrated that 25-12 alloy tubes failed after about 12 months service when used on the top, or hot zone, where service conditions are most severe. When installed on the bottom and in the same heat zone, these tubes would last an average of nearly twice as long.

The furnaces in which the first eight 22H tubes were installed have 46 "W" type tubes, 23 each on top and bottom. Tube operating temperatures vary from 1700 to 1925 F, depending upon their placement, top or bottom, and in the four heat zones of the furnaces.

The first 22H tube was installed in a top position in the hot zone. After 18 months the tube was removed for examination and found to be in good condition. It was then installed in a position on the bottom of a second furnace where it has operated at a temperature of about 1850 F for 60 months. This makes a total of 78 months of operation in the hot zone and the tube is still in service.

A 25-12 alloy tube installed in the same top position in the same furnace failed after 10 months of operation.

The second tube to be installed replaced a 25-12 "W" type which failed after 10 months in another top position of the same furnace. This 22H tube was removed after 64 months of operation to permit a major overhaul of the furnace. This tube was found to be in good operating condition and will be reinstalled in another furnace when required.

Five other 22H tube histories show that they have been in operation in the top of the furnace, where failure occurs more readily due to higher temperatures, for as long as 66 months. Four of the tubes show no sign of failure at the end of five years. One failed at the end of 46 months giving approximately three times the life of a typical 25-12 installation.

According to the National Alloy Division, developers of the new high temperature alloy, initial cost of 22H over their 25-12 is approximately double. However, service life is from at least three to five times as great in this application, making their use economical where temperatures range from 1800 to 2200 F. When downtime costs and loss of production are computed, initial price differential becomes insignificant.

In the furnaces where the 22H tubes were first used, tube annealing runs at the rate of 5000 lb per hr. To replace a tube the furnace must be shut down and allowed to cool for 48 hours. Eight more hours are required to replace each tube and another eight hours are lost in bringing furnace back to operating temperature.

Even when maintenance work can be done on the weekend, when the furnaces are normally down, a minimum of two shifts are lost. Brickwork is involved in each tube change.

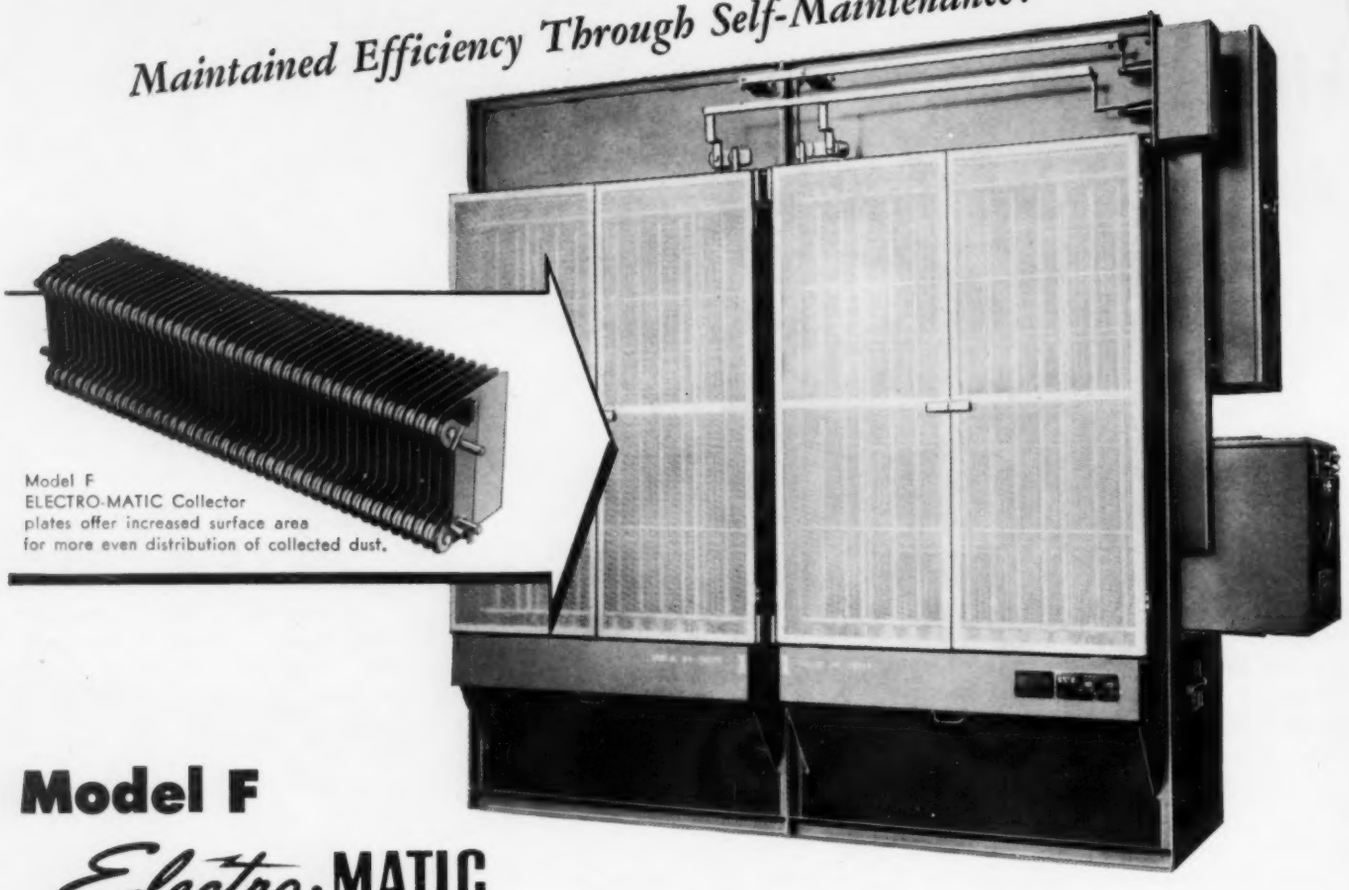
In addition to the cost of downtime, failure of a firing tube means immediate product trouble. To prevent oxidation of the carbon tubing as it is annealed a five-ounce positive pressure DX gas atmosphere is maintained in the furnace during operation. Any failure in a tube leaks gases into this controlled atmosphere, contaminating the product. Rather than coming off the furnace runout table a dark blue, the tubing is grey and scaley.

With the exceptionally long life of 22H the user found failure of support brackets had become a source of trouble. Currently, they are converting all furnaces to 22H on top and are using brackets of the same high temperature alloy. Since the new brackets will give the tubes better support over a longer period of time, it is anticipated that the long life of 22H tubes will be further increased.

Even though temperatures in the four zones along the bottom of the furnace are not as critical, the user is considering changing bottom tubes over to 22H. In fact, one furnace has been completely converted to 22H.

In many applications of 22H since its introduction Blaw-Knox finds it will permit (1) increased furnace capacity and efficiency by increasing the rate of heating with higher heat heads, (2) practical engineering design to 2200 F, and (3) longer alloy life per dollar invested.

Maintained Efficiency Through Self-Maintenance!



Model F
ELECTRO-MATIC Collector
plates offer increased surface area
for more even distribution of collected dust.

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Delivers Uniformly Clean Air, Continuously, Around the Clock

WANT a continuity of clean air that won't vary in quality from one day, month or year to another? It's yours with the Model F ELECTRO-MATIC—the new electronic precipitator whose continuous high efficiency is assured through constant self-cleaning.

The cleaning efficiency of the Model F ELECTRO-MATIC extends over a wide range of particle sizes, from smoke to largest air-borne materials. Its "capacity for work" is increased, too. Newly designed collector plates increase surface area 53% to further reduce possibility of dust build-up and, at the same time, slows down air velocity between plates by 25%.

But here's the payoff! Unlike most other filters, ELECTRO-MATIC's efficiency can't taper off due to the accumulation of dust. Continuous self-cleaning action keeps collector plates in constant fighting trim. There's no time out for washing down with hot water. No need for extra sewer or water connections. ELECTRO-MATIC maintains its own rigid housekeeping schedule without regard to clock or calendar.

Yes, if performance is the payoff, the Model F ELECTRO-MATIC is definitely today's finest electronic filter. For complete product information, call your local American Air Filter representative, or write for Bulletin 250.

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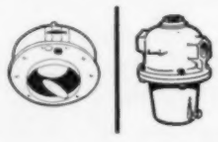
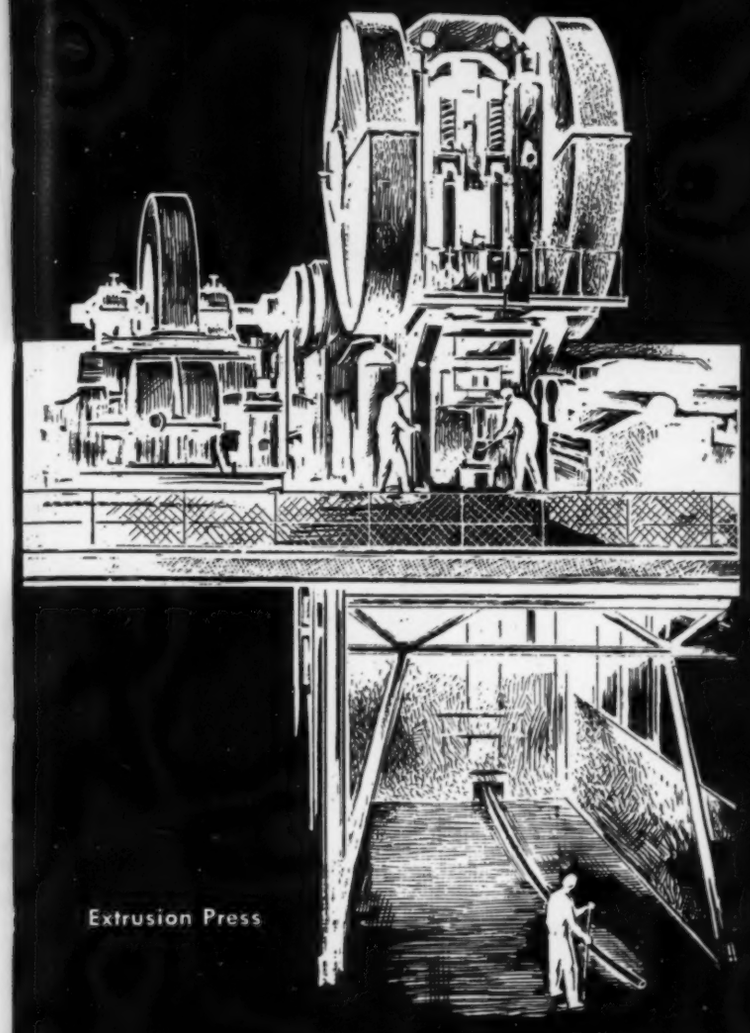
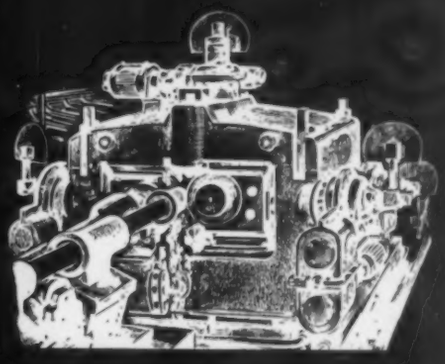


Unit Heaters Herman Nelson

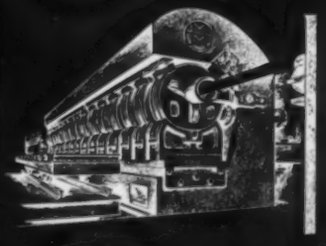
Illinois Steam Heating Specialties



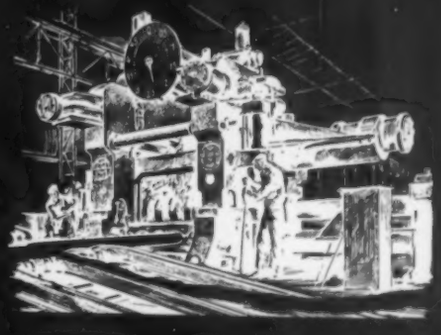
Extrusion Press



Reeler



Stretch Reducing Mill



Automatic Plug Mill

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with new, advanced tube-mill machinery

Whether your plans include the purchase of a single machine or a whole mill . . . Mannesmann-Meer can help you stay ahead in the race for high-speed tube production. You can obtain completely automatic operation of any tube-making process through Mannesmann-Meer engineering.

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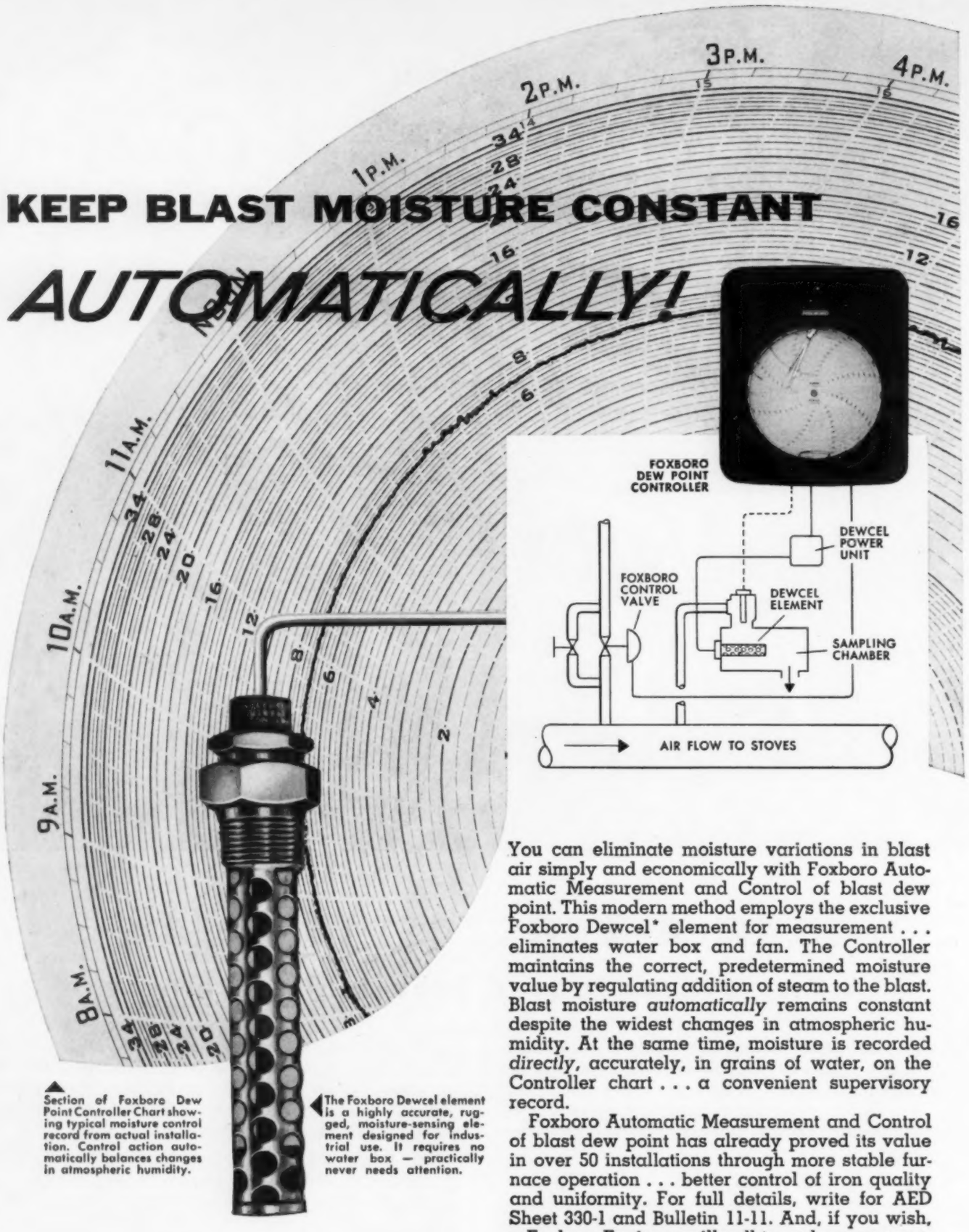
KEEP BLAST MOISTURE CONSTANT AUTOMATICALLY!



▲ Section of Foxboro Dew Point Controller Chart showing typical moisture control record from actual installation. Control action automatically balances changes in atmospheric humidity.

◀ The Foxboro Dewcel element is a highly accurate, rugged, moisture-sensing element designed for industrial use. It requires no water box — practically never needs attention.

You can eliminate moisture variations in blast air simply and economically with Foxboro Automatic Measurement and Control of blast dew point. This modern method employs the exclusive Foxboro Dewcel* element for measurement . . . eliminates water box and fan. The Controller maintains the correct, predetermined moisture value by regulating addition of steam to the blast. Blast moisture *automatically* remains constant despite the widest changes in atmospheric humidity. At the same time, moisture is recorded *directly*, accurately, in grains of water, on the Controller chart . . . a convenient supervisory record.

Foxboro Automatic Measurement and Control of blast dew point has already proved its value in over 50 installations through more stable furnace operation . . . better control of iron quality and uniformity. For full details, write for AED Sheet 330-1 and Bulletin 11-11. And, if you wish, a Foxboro Engineer will call to make recommendations for your furnace. **The Foxboro Company, 586 Neponset Ave., Foxboro, Mass., U.S.A.**

*Trademark

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FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

AUTOMATIC CONTROL OF BLAST DEW POINT

EATON

DYNAMATIC®

SINGLE PACKAGE FRACTIONAL HP AJUSTO-SPEDE® DRIVES

Provide Stepless Adjustable Speed from an AC Power Source

Sizes and Types for Hundreds of Industrial Applications

Dynamatic Ajusto-Spede® Drives, part of a family of diversified eddy-current equipment, provide an economical solution to many adjustable speed drive problems.

The Fractional Horsepower Ajusto-Spede, a single package design, combines an AC constant speed induction motor, eddy-current coupling, and electronic control. Standard modifications provide for the addition of electrically operated fail safe friction brakes, or speed reducers with numerous gear reduction ratios.

Fractional Horsepower Ajusto-Spede Drive power is taken directly from 115/220 volt, single phase or 220/440 volt, 3 phase lines. Sizes are ¼, ⅓, ½ and ¾ horsepower at 1600 RPM; ½, ¾ and 1 horsepower at 3200 RPM.

Friction brakes for quick stopping or fast cycling operation are furnished in two capacities—1½ and 3 pounds feet of torque.

Gear reductions with 10 ratios between 5-to-1 and 100-to-1 are supplied with 1600 RPM Ajusto-Spedes.

Ajusto-Spede® Advantages

- ★ **Constant torque speed range: 25 to 1 with either 1600 RPM or 3200 RPM Ajusto-Spedes.**
- ★ **Control accuracy: 2 per cent of top speed at any point within the speed range.**
- ★ **Minimum wiring to power line.**
- ★ **Remote "one knob" control operation up to 100 feet.**
- ★ **Rugged plug-in type integral one-tube electronic control.**
- ★ **Permanently sealed grease-packed bearings.**

For more detailed information, write for your free copy of the Dynamatic Fractional Horsepower Ajusto-Spede Bulletin, FAS-5.

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They work, too, for pennies an hour—cost less per year to own and less to operate...last years longer with only negligible down time.

Experienced operators invariably favor Automatic Electric Trucks, too, for the smooth, fume-free ride with no gear shifting, safer low center of gravity, and smoother handling in tight quarters. In short, Automatics excel in every wanted lift truck quality.

There's a model, too, that's exactly suited for your requirements. You'll find it fully described in Automatic's new 16-page catalog of America's most complete line of electric-driven trucks. *Write for your copy today.*

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SKYLIFT GIANT With fork or ram, capacities to 100,000 lbs.

DOCKER—for congested areas: 1,000 to 3,000 lbs.

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50th Automatic Anniversary

WORLD'S LARGEST EXCLUSIVE BUILDER OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.
2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.
3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.
4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.
5. Sleeves carried on bearing rings, located on transverse center line of hub spline faces (the load-carrying surfaces) . . . no crank action, no vibration.
6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3006 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

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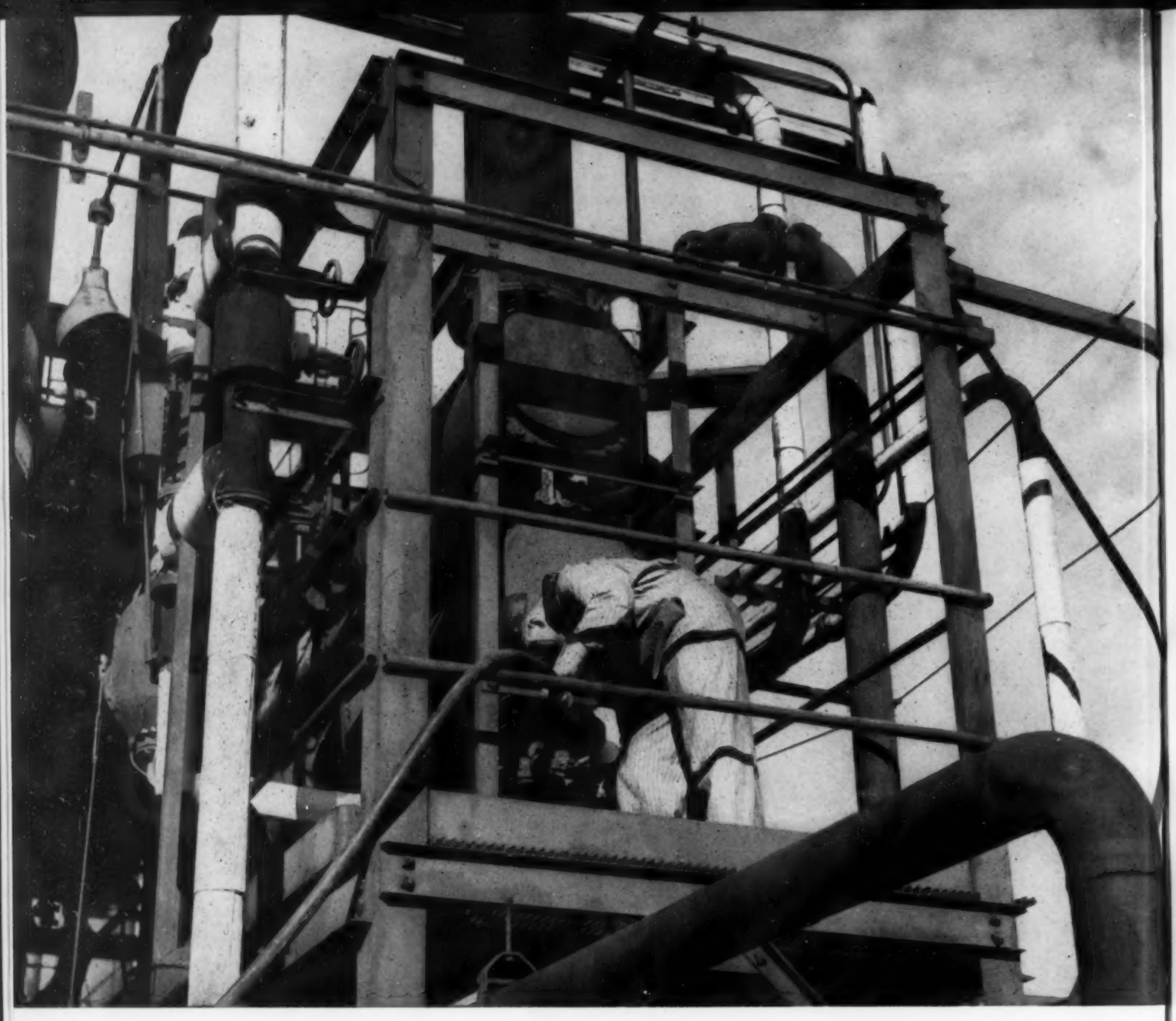

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In over 15 years our trained engineers have serviced virtually every kind of equipment in plants, mills and refineries throughout industry. In fact, Dowell has cleaned over 10,000 boilers alone!

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chemical cleaning service for industry

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A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

May 1

▲ According to the U. S. Dept. of Commerce, total 1955 shipments of iron and steel castings were 17,473,000 short tons, exceeding 1954 shipments by 29 per cent.

▲ Eastern Stainless Steel Corp. announced a new $5,277,500 expansion program and plans to offer rights to its common stockholders to subscribe to 15-year convertible subordinate debentures in order to finance the program.

May 2

▲ Allis-Chalmers Manufacturing Co. shareholders, at their annual meeting, approved a 2 for 1 common stock split and authorized the issue of an additional 2,500,000 shares at the new par of $10.

▲ The Labor Department announced that strikes in the first quarter of 1956 resulted in the loss of 6,200,000 man days of production, the highest in this period since 1950, and ascribed the high level of loss mainly to the Westinghouse Electric strike and the strike at four Republic Aviation plants on Long Island.

May 3

▲ Compilation of reports of 485 companies in 28 classifications shows that for the quarter ending March 31, 1956, net profit climbed 12.4 per cent above the same period in 1955. Comparatively, however, no three-month period in 1955 showed less than 25 per cent rise over the same period in 1954.

May 4

▲ Inventories of durable goods in March, 1956 totaled over $27,000,000,000, 14 per cent above a year ago. New orders in March declined sharply, the total of $13,400,000,000, seasonally adjusted, compares with $14,300,000,000 in February.

May 7

▲ Further decline in spot copper resulted in a new price of 42 cents a lb in London, two cents per lb less than a week ago. Locally, scrap copper declined an additional two cents to 34½ cents per lb.

▲ The AISI reports that the operating rate of the steel industry for the week of May 7, 1956 is scheduled at 96.5 per cent of capacity. This is equivalent to 2,375,000 tons compared with 2,373,000 tons one week ago and 2,345,000 tons one year ago. Index of production for the week is 147.8.

May 9

▲ The U. S. Depts. of Commerce and Labor reported construction outlays in April of $3,300,000,000. Total spending for the first four months 1956 amounted to $11,800,000,000 unchanged from the 1955 total for the same period.

▲ The AISI announced that shipments of finished steel products in March, 1956 totaled 8,255,824 net tons, highest monthly total in history, including a record domestic shipment total of 7,913,383 tons.

▲ The U. S. Dept. of Commerce reported that shipments of iron and steel castings during February amounted to 1,478,000 short tons. This is a decrease of 2 per cent below January, 1956, and 13 per cent above February, 1955.

May 10

▲ The Dept. of Commerce reported that the national production of goods in the first three months of 1956 advanced to an annual rate of $398,600,000,000, up $23,300,000,000 over the output at March, 1955.

▲ The F. W. Dodge Corp. reported contract awards for future construction in the 37 states east of the Rockies in April, 1956 totaled $2,421,497,000, up 4 per cent above April, 1955.

May 11

▲ Westinghouse Electric Corp. announced plans for a $300,000,000 expansion program over the next five years, to be evenly split between heavy equipment and consumer products. At the present time financing is planned from earnings at the rate of $60,000,000 to $75,000,000 to be spent annually.

▲ Because of increased cost of manufacture, the U. S. Steel Corp. raised prices on extras equivalent to an overall average increase of about one per cent on a variety of its products including carbon special quality bars, carbon rods, wire and semi-finished products, and alloy steels.

▲ The Bureau of Mines reports that the consumption of ferrous materials scrap and pig iron during March, 1956 totaled 13,025,000 gross tons in comparison with 12,217,245 gross tons in February, 1956. Of this 51.7 per cent was scrap.

May 14

▲ The AISI reports that the operating rate of the steel industry for the week of May 14, 1956 is scheduled at 95.7 per cent of capacity. This is equivalent to 2,355,000 tons compared with 2,343,000 tons one week ago and 2,338,000 tons one year ago. Index of production for the week is 146.6.

▲ Spot copper rose in price last week 2½ cents, closing in London Friday at 44½ cents per lb. The U. S. Market appeared settled at 45 cents by custom smelters and 46 cents by major producers.

May 15

▲ Titanium Metals Corp. of America announced a new price of $3.25 per lb, a reduction of about 20 cents, on titanium sponge metal. Prices were also reduced on all mill products, resulting in reductions from 65 cents to $1.00 per lb for products such as sheet or strip.

May 16

▲ Despite steelworkers assertion that their demands on the industry can be settled for 20 cents to 30 cents an hour, steel producers claim the cost will reach nearly 60 cents an hour. The "package," formally adopted by the Union's wage policy committee, includes demands for a substantial wage increase, premium pay for week-end work, a lay-off pay plan, and greater vacation benefits.

▲ I. W. Wilson, president of Alcoa, advised that the price of aluminum may have to be increased, from the 25.90 cents per lb for ingots, if the industry is to be in a position to develop and adequately serve expanding aluminum markets. It is estimated that Alcoa will spend $600,000,000 to expand its facilities during the next 5 years.

▲ The Labor Dept. advised that privately-financed housing starts in April held at a rate of 1,100,000 annually. In April, 1955 the yearly pace was 1,374,000 units.

May 17

▲ Deliveries of new domestic freight cars in April showed a slight decrease to 5943 from 5949 in March, compared with 2750 cars in April, 1955 according to the ARCI. Orders in April totaled 6559 compared with 1618 in March, 1956. Backlog of cars on order as of May 1, 1956 was 137,436.

May 18

▲ The Aluminum Assn. reported primary production of aluminum during April, 1956 totaled 289,452,612 lb in comparison with 291,790,372 lb in March, 1956 and 252,788,467 lb in April 1955.

▲ Barium Steel Corp. announced that a loan agreement had been concluded with the General Electric Co. amounting to $5,000,000 at 4½ per cent interest, extending to July 1960, with repayments on an equal monthly basis. Barium Steel also agreed to supply GE with a portion of their steel requirements for the next five years.

▲ Atlantic Steel Co. announced an increase in base price for hot rolled steel bars to $103 per ton, a boost of $6. Also, the company stated it will not absorb freight costs on bars or other rolled products.

▲ Steel scrap prices dropped for the third time recently. An additional $1 per ton decline in Pittsburgh brought steel scrap prices down $5 per ton in the last two weeks. No. 2 melting scrap sold for $43.

▲ The Industrial Heating Equipment Assn. reported that orders for April, 1956 totaled $8,803,284, a 15 per cent increase over orders of $7,638,549 for April, 1955. Orders received in April, 1956 in the induction and dielectric segment of the industry totaled $1,455,662 compared with April, 1955 orders of $759,788.

▲ An advance report of the 1954 Census of Manufacturers released by the U. S. Dept. of Commerce, Bureau of the Census, states that during 1954 steel foundries shipped products valued at $542,000,000, an increase of 34 per cent over 1947's total of $403,200,000. Average employment dropped 10 per cent to a total of 55,800 employees in 1954.

May 21

▲ The AISI reports that the operating rate of the steel industry for the week of May 21, 1956 is scheduled at 96.6 per cent of capacity. This is equivalent to 2,379,000 tons compared with 2,345,000 tons one week ago and 2,326,000 tons one year ago. Index of production for the week is 148.1.

May 22

▲ Kaiser Steel Corp. announced they would start at once on a $113,000,000 expansion of the Fontana, Calif. mill, scheduled for completion early in 1958. The new facilities will increase production capacity of steel ingots and finished steel by 40 per cent.

May 23

▲ At the National Assn. of Purchasing Agents annual meeting, Mr. White, president of Republic Steel Corp., stated that the steel pricing policy should be thoroughly reviewed, claiming the industry is caught between demands for high cost expansion and inadequate prices dating back prior to World War II. He advocated an increase in steel prices to help finance the necessary expansion in steel production capacity over the next decade.

▲ Resistance Welders Manufacturers' Assn. members' statistics report for April, 1956 revealed new orders totaled $3,500,000; shipments totaled more than $3,500,000, with a backlog at the end of April of almost $22,000,000.

May 24

▲ Steel scrap prices further declined in Pittsburgh, with No. 1 heavy melting scrap breaking at $46 a ton, a drop of $3. This drop totals $8.00 decline since the high reached in April.

▲ Spot copper in London declined to 40½ cents per lb, off 14 cents since the high set in March; in U. S. custom smelters quoted copper at 43 cents a lb, down 2 cents from the prevailing level maintained since May 2. Prices of scrap copper were also down 1½ cents per lb.

May 25

▲ Henry Ford II, president of Ford Motor Co., reported to stockholders at a meeting in Dearborn, that the second and third quarters profits will be substantially lower than last year, and that production and sales will be considerably curtailed, at least through the third quarter. He also predicted that new cars sales will fall below 6,000,000, from last year's 7,400,000.

▲ The U. S. Dept. of Commerce reported that shipments of iron and steel castings during March 1956 amounted to 1,512,000 short tons; unfilled orders at the end of March 1956 totaled 1,864,000 tons.

May 28

▲ The AISI reports that the operating rate of the steel industry for the week of May 28, 1956 is scheduled at 96.5 per cent of capacity. This is equivalent to 2,375,000 tons compared with 2,396,000 tons one week ago and 2,312,000 tons one year ago. Index of production for the week is 147.8.

▲ Negotiations started today in Pittsburgh, in separate conferences between USW and U. S. Steel Corp., Bethlehem Steel Co., and Republic Steel Corp. Discussions with several other companies will open tomorrow.

May 29

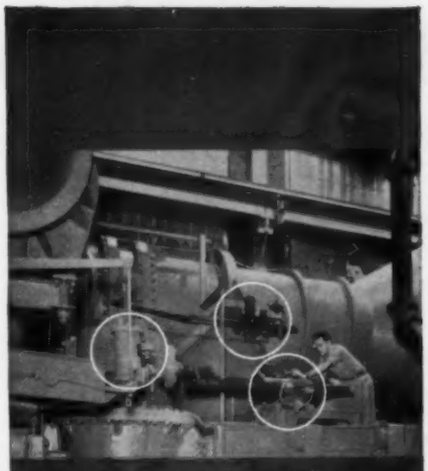
▲ U. S. copper producers report a complete sell-out for June delivery at the current quotation of 46 cents per lb. Copper prices to British consumers were slashed to 40 cents per lb, down 3¾ cents from the April 30 level, and down more than 8 cents from the price prevailing in late February. U. S. custom smelters lowered prices an additional cent, to 42 cents per lb; however, major producers continued to ask 46 cents.

May 31

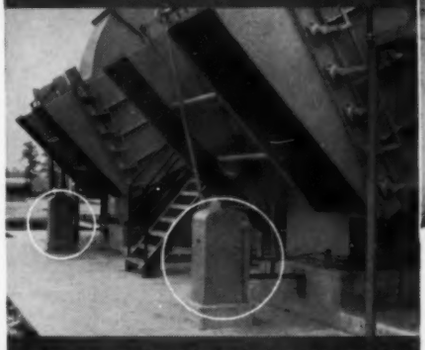
▲ Patent rights for production of super-refined alloys by a new consumable electrode vacuum furnace process were sold by Allegheny Ludlum Steel Corp. to Midvale-Heppenstall Co. Allegheny Ludlum will furnish the know-how for the entire process and Midvale plans to proceed immediately to install production facilities.

▲ Prices of scrap steel dropped for the fifth time in a month, with the price off $1 to $45 a ton for No. 1 heavy melting scrap in the Pittsburgh area.

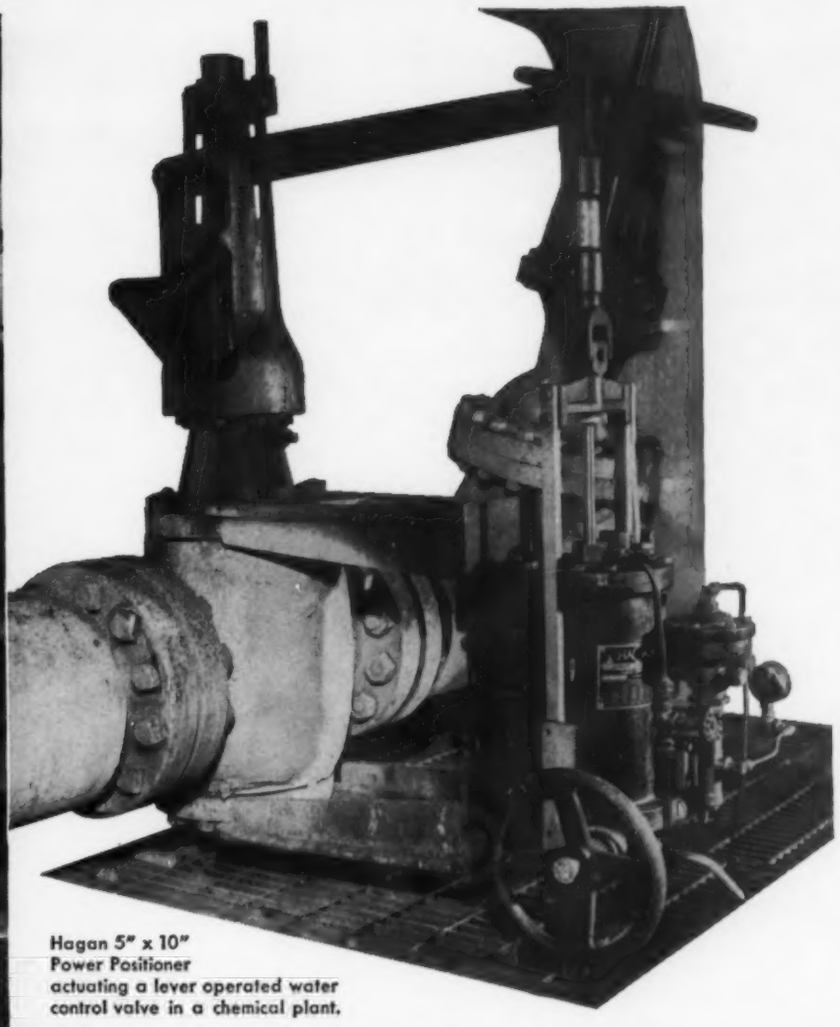
▲ The USW reached an agreement with U. S. Steel, Republic, and Bethlehem for joint negotiations on new contracts. This deviates from the previous procedure whereby the U. S. Steel bargained alone with the union and its settlement set the pattern for the industry. This new procedure is designed to speed up consideration of the union demands in an attempt to arrive at a compromise before the strike deadline July 1.



Two 8" x 20" and one 5" x 20" Hagan Power Positioners operating plug valves on a wind tunnel in an aeronautical test facility.



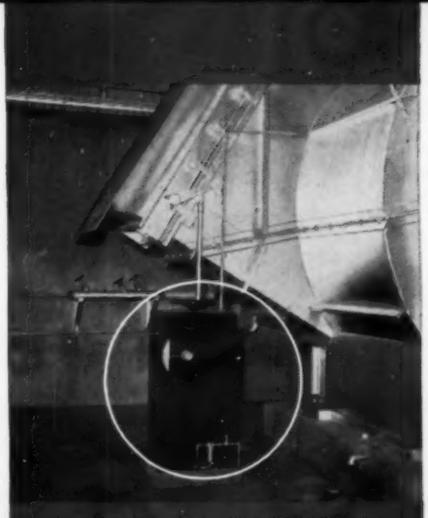
Louvers on forced draft fans operated by Hagan 6" x 10" Power Positioners. Note outdoor installation.



Hagan 5" x 10" Power Positioner actuating a lever operated water control valve in a chemical plant.

HAGAN POWER POSITIONERS

HIGH PRECISION—LOW MAINTENANCE!



8" x 14" Power Positioner operating louvers of forced draft fan on a large public utility boiler.

Hagan Power Positioners provide the "muscles" for thousands of control applications in every type of industry—wherever torque and positioning accuracy requirements are severe.

Hagan Power Positioners are economical, both in first cost and in the low maintenance costs which result from their uncomplicated design and strong construction. Many Hagan units are still giving trouble-free, dependable service after years of exposure to rigorous conditions, such as high ambient temperature (up to 160°), corrosive atmospheres, or outdoor installations.

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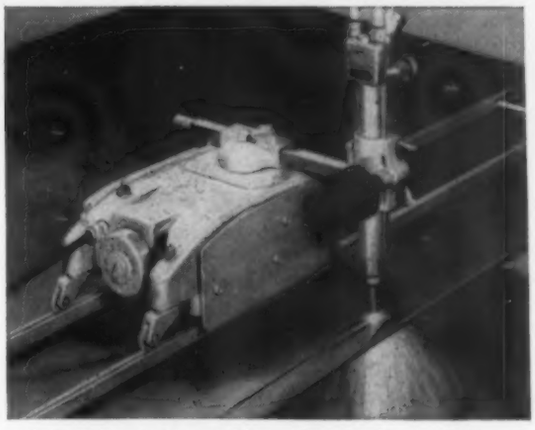
Machine-Cutting Clears the Way to $13,000 Savings

One steel company is saving up to $13,000 a year by using oxygen shape-cutting machines for making ingot and pan links from steel plate.

Previously these parts were forged at an annual cost of approximately $30,000. The speed and accuracy of oxygen shape-cutting cut costs to $17,000 a year—a savings of more than two dollars on each of the 5,000 parts made.

Machine-cutting setups are speeding fabrication and cutting costs throughout industry. Whatever your part-producing needs are—cutting hundreds of parts at one time, or one-of-a-kind turnout—there are LINDE oxygen shape-cutting machines to help you save hours and dollars in production time.

LINDE service engineers will be glad to help you determine the shape-cutting setup to best serve your job needs. Call your local LINDE representative for more information. Start saving now—call him today.



This lightweight portable cutting machine weighs only 38-lbs., and can cut metals up to 10-in. thick. It can cut straight lines, circles, and plate edge preparations in from 4-in. to 32-in. per minute.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
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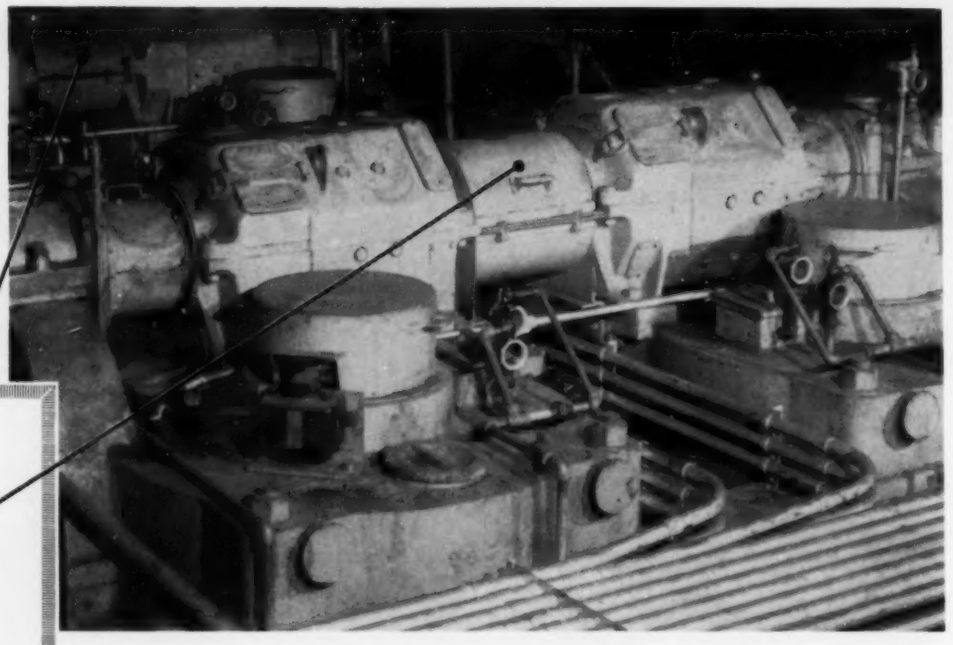
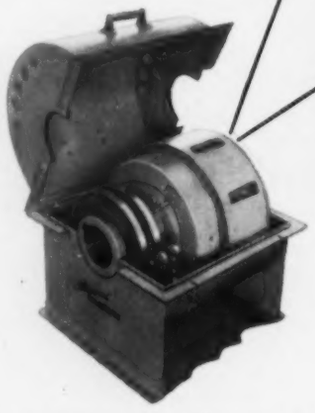


Five Stearns clutches synchronize screw-downs on a large rolling mill. Covers shield clutch from dust, moisture and external damage.



Style E multiple-disc Stearns magnetic clutch used for screw-down duty. Sizes available for all screw-down auxiliary motors.

Low Inertia Stearns Magnetic Clutches Keep Screw-Downs Synchronized on Mile-a-Minute Rolling Mills

QUICK-ACTING, high-torque Stearns magnetic clutches engage and disengage screw-down drives with the lowest possible inertia — a prime necessity on today's rolling mills running at speeds often greater than 6,000 fpm. Because of their high efficiency, more Stearns magnetic clutches are used on steel mill screw-downs than all other makes combined. Here are some of the features that have put Stearns out front, and keep it there:

Precision automatic control — Clutches can be operated through push buttons, electric-eye systems, remote switches or manual controls.

Lightweight, compact — Stearns patented multiple friction-disc clutches provide greater torque than bulky, far heavier single-disc types — offer extremely low inertia value to driven end. This is especially important when little or no drifting is desired after clutch is disengaged.

Few wearing parts — No toggles, pins, yokes, shifters to wear and get out of order. Lining wear increases torque, making frequent adjustment unnecessary.

Simple adjustment — No set screws, cams, wedges, spacers or lock nuts. Simply depress adjustment lock-pin, rotate armature to next notch.

Easy access — Can be removed vertically with motor from mill. Housing covering entire unit is split either horizontally or vertically for easy inspection. Magnetic hub is detachable when used on screw-downs.

For improved quality control it will pay you to replace old-style clutches with new Stearns multiple-disc clutches on existing installations . . . specify Stearns for new mills. Write for complete details.

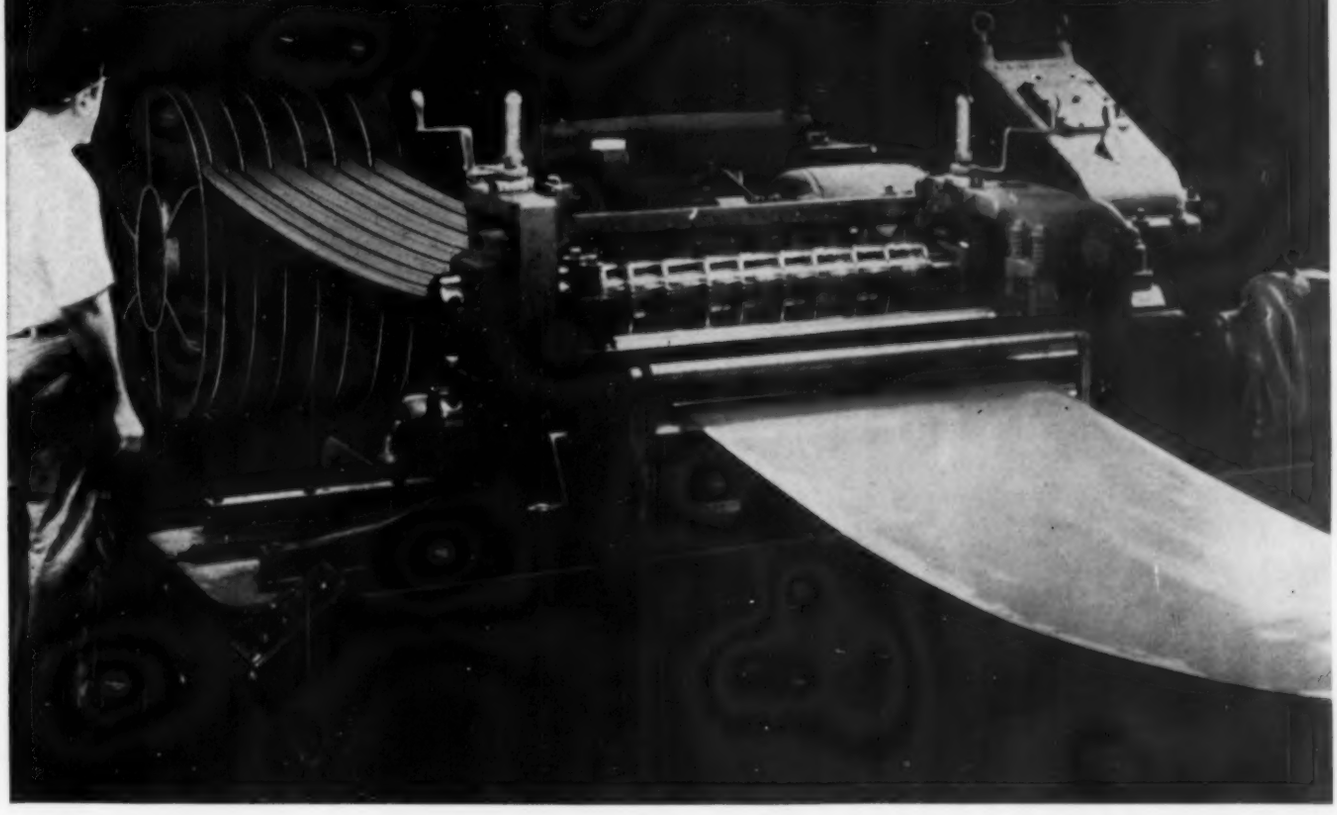
1121

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

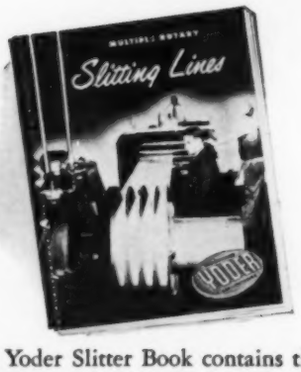
STEARNS MAGNETS

STEARNS MAGNETIC, INC., 681 S. 28th St., Milwaukee 46, Wisconsin

AN EFFICIENT SLITTING LINE



...with big savings possibilities



The Yoder Slitter Book contains time studies, production records, and other valuable data on the economics as well as mechanics of slitter operation. A copy is yours for the asking; also estimates and recommendations.

The standardized series of Yoder Uncoilers, Slitters and Recoilers make possible an infinite number of combinations for highly efficient coil and sheet slitting.

At a substantial saving in first cost, one of these combinations will meet widely varying production needs of fabricating shops as efficiently as higher priced, built-to-order equipment (also designed and built by Yoder) for very big tonnage requirements.

A Yoder standardized slitting line is a most profitable production tool which will pay for itself in short order on strip requirements as low as 100 tons per month, even less. Equally important is the ability in a few hours to meet expected and unexpected needs for slit strands, from a relatively small stock of standard width coils. This greatly reduces strip inventories and simplifies production planning.

THE YODER COMPANY • **5495 Walworth Avenue, Cleveland 2, Ohio**

ENGINEERING YODER MANUFACTURING

ROTARY SLITTING LINES
COLD ROLL FORMING MACHINES
ELECTRIC-WELD PIPE AND TUBE MILLS

Catenary Furnaces

A 12,000 lbs/hour Fuel-fired Catenary Annealing Furnace for stainless strip used in line with spray quench followed by descaling and pickling baths.

FURNACE CHARACTERISTICS

Inside Dimensions	50'-0" long x 7'-0" wide x 6'-8 3/8" high
Fuel Input	1,800,000 BTU/hour
Operating Temperature Range	1200 to 2250°F
Stainless Strip	Cold reduced—annealed in gauges from 0.007" to 0.125"
Stainless Strip	Hot rolled—annealed in gauges from 0.093" to 0.200"

Three (3) zone proportioning control

Complete control over fuel-air ratio to maintain desired atmosphere in furnace

DREVER COMPANY

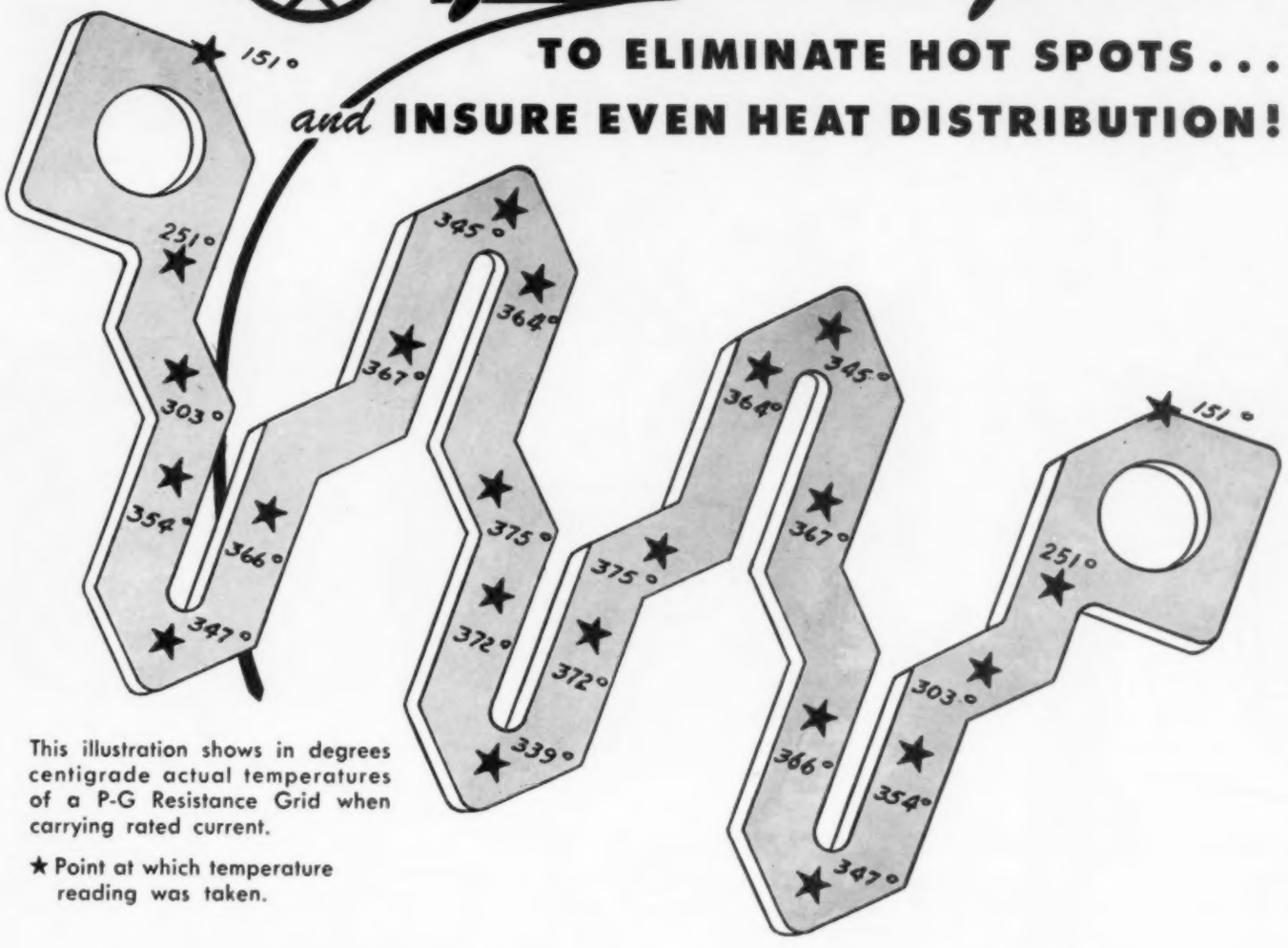
RED LION RD. & PHILMONT AVE., BETHAYRES, PA.

23

P-G *Grid Designed*

TO ELIMINATE HOT SPOTS . . .

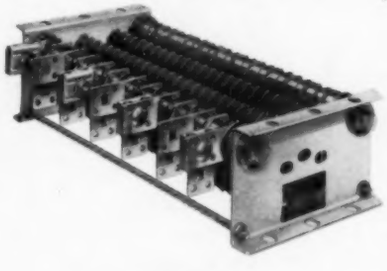
and INSURE EVEN HEAT DISTRIBUTION!



This illustration shows in degrees centigrade actual temperatures of a P-G Resistance Grid when carrying rated current.

★ Point at which temperature reading was taken.

P-G *Steel Grid Resistors* HAVE DEMONSTRATED THIS FOR MANY YEARS!



Laboratory tests of temperature distribution on "Type T2 Resistance Grids" at rated current indicate extremely uniform temperatures over the entire grid surface. Note also, that temperatures at points of contact are much cooler than at any other point on the entire grid. You, too, can obtain better results by specifying P-G for your next application.

Complete data given in **BULLETIN No. 500** . . . *Copy on request*

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

Here's the man

to solve your roll problems

Ohio Rolls

Ohio Steel representatives show you how with

The Ohio Roll Representative who calls on you knows the metal industry, production processes and his products. He can tell you what you need to know about performance, life, hardness and relative strength of rolls. His recommendations are supported by technical data developed by Ohio's engineering, chemical and metallurgical departments. He knows rolls, and he knows that OHIO ROLLS give long, profitable service under critical operating conditions . . . because they are delivered only after exhaustive chemical and metallurgical tests and minute inspection.

When you need rolls—large or small—call in your Ohio Roll representative. He can help you solve your roll problems quickly and efficiently.

OHIO ROLLS SERVE THE WORLD

shaping metal for all industry

Carbon Steel Rolls • Ohioloy Rolls • Ohioloy "K" Rolls • Ohio Double-Pour Rolls
Chilled Iron Rolls • Denso Iron Rolls • Nickel Grain Rolls • Special Iron Rolls
Nioloy Rolls • Flintuff Rolls • Forged Steel Rolls

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO — **Plants at Lima and Springfield, Ohio**

ORG

Industry News...

FOUR COKE OVEN BATTERIES TO BE REBUILT AT CLEVELAND WORKS OF REPUBLIC STEEL

▲ A rebuilding program is underway on the four old coke oven batteries at Republic Steel Corp.'s Cleveland, Ohio, plant.

The entire job of dismantling the old and building a new battery will cost more than $5,000,000 and will take about 12 months. When it is finished, work will start on a second battery. The entire job will take about five years.

Only the pad, or base, of the battery will remain after the dismantling operation is completed. New regenerators will be built on top of the pads to preheat the air used in underfiring the ovens. The new ovens will rise above the regenerators.

Height of the battery from the base of the regenerators to the top of the ovens will be approximately 26½ ft. Each battery will be more than 200 ft long and 37 ft deep.

The new ovens will be of Koppers design, 12 ft 6 in. high from oven floor to roof, 17 in. average width and 37 ft long. This compares with a height of 9 ft 10 in. on the old, an average width of 18¼ in. and a length of 37 ft.

With their increased height, the new ovens will have 15 per cent greater capacity than the old.

Each of the new batteries will have double collecting mains to capture all gases created in the coking process and carry them to the chemical plant. The Numbers 6 and 7 batteries already are equipped with such mains.

To facilitate the exhausting of gas from the ovens during the coking process, one new exhauster has been installed at the plant and two more are planned. The exhausters provide suction for drawing the gases from the ovens to the chemical plant.

Each oven will be equipped with self-sealing doors with stainless steel edges. Similar doors provide a smokeless operation on the newer batteries.

Another feature of the program will be the building of the low quenching tower for the old batteries to a height of 175 ft above ground level to provide for better dispersion of the steam which results when cold water is poured onto the hot coke in the quenching operation.

Under the program, the coke wharf, the location where quenched coke is dumped onto a conveyor line, will be lengthened by 80 ft to a new length of 250 ft. Two new mixer bins will be built and the coal storage bin atop the ovens will be elevated.

As the program progresses, additional work is planned for the chemical plant and the screening station.

NEW BLAST FURNACE FOR FAIRLESS WORKS

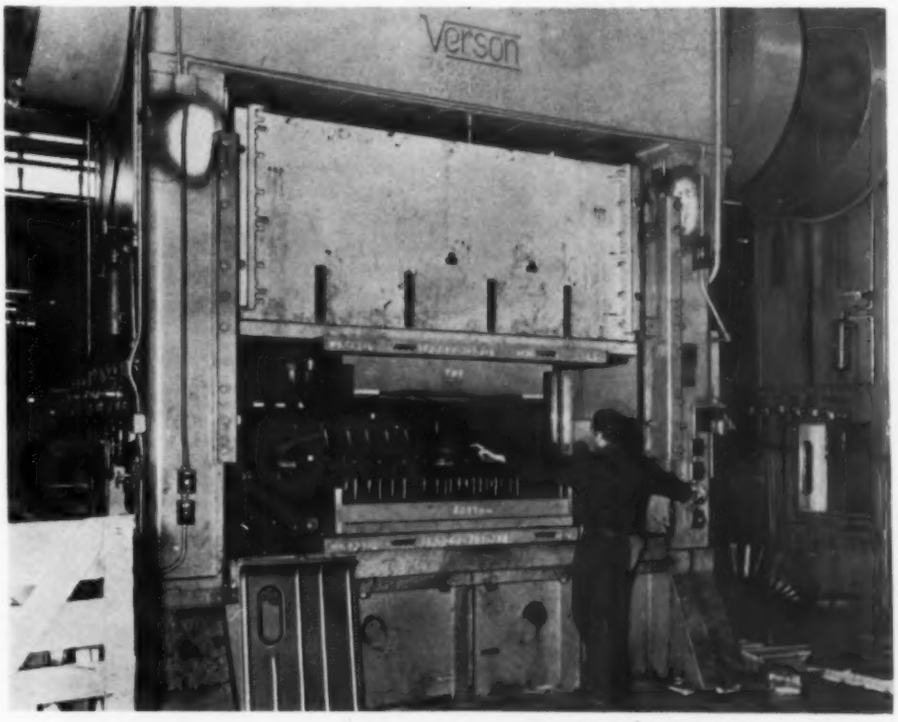
▲ Ironmaking capacity of Fairless Works will be increased by 50 per cent according to an announcement by Harvey B. Jordan, executive vice president-operations, United States Steel Corp. A new blast furnace, identical to the existing twin stacks, will be installed at the plant.

The new furnace will provide Fairless open hearth furnaces with an additional 1600 tons of molten iron daily. This move will substantially increase the mill's annual steel ingot tonnage, result in greater utilization of the finishing facilities now available at the plant and permit closer quality control because of the larger percentage of hot metal available for the open hearth charge. The third blast furnace will also permit the plant to maintain its current production rate, when it is necessary to reline or repair one of the two original furnaces.

Arthur G. McKee and Co. has been awarded the contract for construction of the new stack which will be equipped with an electrostatic precipitator and primary gas washer.

400-TON PRESS INSTALLED BY NEW ENGLAND MILL

This 400-ton blanking, forming, and multiple operations press has been installed at Worcester Pressed Steel Co. The press has a bed area for inserting dies up to 42 in. in width by seven ft in length. Built by Verson Allsteel Press Co., the unit is equipped to blank large sheets of metal at the rate of 1200 strokes an hour. Eight sets of drawing tools can be set on the bed side by side for drawing heavy parts up to eight in. in depth, thus reducing annealing and handling costs.



TIMKEN Company ORDERS 2 MORE DIAMOND ITV UNITS

(WIRED TELEVISION)

AFTER 3 SUCCESSFUL INSTALLATIONS

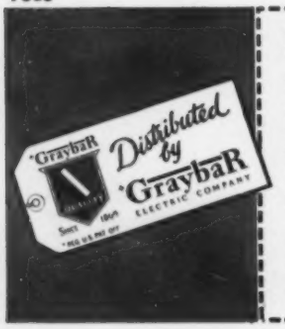
Picture of furnace interior on Diamond ITV viewing screen is watched by remote dispatcher. A flip of a switch and he SEES conditions in another furnace on same screen.

Operator at another control pulpit SEES a visually inaccessible billet loading area for a pusher type furnace.

The Timken Roller Bearing Company made its first application of Diamond Industrial TV in August 1951 for remote observation of the interior of a tube-cooling furnace. Since that time two additional installations have been made to watch (1) the inside of another furnace and (2) the remote handling of billets by a crane. The success of these has resulted in a recent order for two more sets of Diamond ITV.

You, too, probably can use Diamond ITV to substantial advantage. Call your Graybar Distributor or use the coupon below.

7530



DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P. O. BOX 56X
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Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

Name_____

Title_____

Company_____

Address_____

GREAT LAKES CARBON TO EXPAND FACILITIES

▲ The Electrode Division of Great Lakes Carbon Corp. has announced plans to add more than 45 per cent to its annual production capacity of carbon and graphite electrodes, anodes, mold stock, and graphite specialties.

New facilities will be added at the division's plants in Morganton, N. C. and Niagara Falls, N. Y. and are scheduled for completion in May of 1957. Robert B. Wittenberg, vice president and general manager of the division, stated that, with the new facilities and others added since 1952, production capacity will have more than doubled in a five-year period.

The plans also call for greatly increased research and development facilities, and substantial additions to the plant offices.

J & L TO ADD TO AIR POLLUTION CONTROL

▲ Jones & Laughlin Steel Corp. announced it is taking immediate additional steps to bring about further elimination of air pollution, resulting at times from certain operations at its Pittsburgh Works. Appropriations of approximately $2,000,000 has been authorized by the executive committee of the corporation for this purpose.

A major part of the expenditure, $1,500,000, has been authorized for the first stage of installing electrostatic precipitators on the furnaces in the Open Hearth Shop on the South Side. The unit is an experimental project from the standoint of determining design limitations. The results obtained from it will be used as a guide to the corporation for completing the installation.

The balance of the program includes a mechanical dust collector for the coal pulverizing unit at the Eliza Blast Furnaces, and the substitution of low-ash coal for the regular boiler "feed," to reduce smoke from the boiler at Eliza Furnaces. In addition, studies are under way on possible reduction in the electrical load on the Eliza boilers, which in turn should reduce the smoke from the boilers.

Here's another complete ore handling system

designed, built, erected by LINK-BELT

Transporting iron ore to storage at 6000 tph, this 1260-ft. Link-Belt conveyor travels at 500 fpm. Series 200 impact idlers are used along 500-ft. loading area. This 60-in. wide belt also handles coal and limestone.

Power for reversible storage belt conveyor is delivered through Link-Belt parallel shaft drives.

Link-Belt traveling tripper-stacker on distributing belt conveyor stacks coal on the right, ore on the left.

This 60-in. wide Link-Belt belt conveyor is inclined 16½ degrees and delivers to screen house.

Eastern mill delegates responsibility for conveyors from docks, to and from storage, to blast furnaces

PAST experience with the efficiency of similar Link-Belt bulk materials handling systems prompted a repeat order from this eastern mill of a major steel company. Today, in mills throughout the country, Link-Belt conveyors are providing efficient, economical handling of iron ore, coal, sinter and limestone.

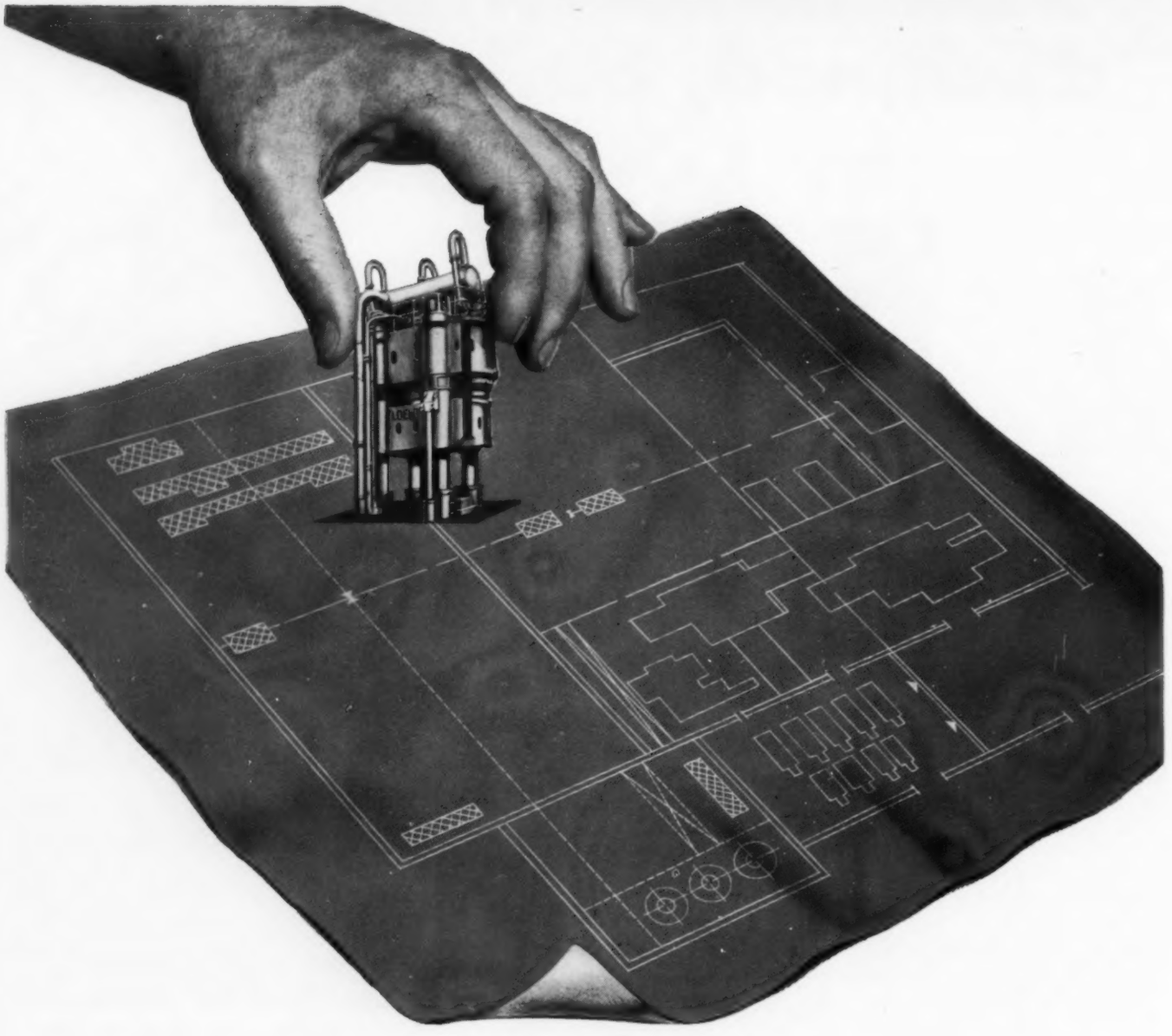
When you rely on Link-Belt for one-source service, we accept full responsibility for placing your system in successful operation. Link-Belt engineers will work with your consultants and engineers to give you a bulk handling system built to your exact requirements. For complete information, call your nearest Link-Belt office.

14.157

LINK-BELT

MATERIALS HANDLING, PROCESSING AND POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



how Loewy-Hydropress engineers can help you ... from plans to full scale production

Our staff of 400 engineers is at your service for any project, large or small. Here's what we offer:

- Research and development, including analysis of materials, methods, machinery operations, surveys and analytical reports.
- Design, construction and installation of forging presses, extrusion presses, powder metal presses, precision deep drawing presses, rolling mills—in fact, any equipment for metal forming and processing.
- Planning and erection of complete plants, including plant layout, structures, material flow and handling. We write specifications and take entire responsibility for procurement.

Whether you require only preliminary consulation on an idea, or a complete "turn-key" job, you can depend on Loewy-Hydropress. For a copy of our bulletin L-144, write to Department 117, 350 Fifth Avenue, New York 1, N. Y.

BALDWIN BLH LIMA-HAMILTON

LOEWY-HYDROPRESS
BALDWIN-LIMA-HAMILTON
DIVISIONS: Austin-Western • Eddystone • Electronics & Instrumentation • Hamilton • Lima • Loewy-Hydropress • Madsen • Pelton • Standard Steel Works

J & L's new slab scarfer at Pittsburgh Works will be equipped with dust collectors, removing another potential source of ordinance violation.

TO BUILD REFRACTORY PLANT IN GARY, IND.

▲ Plans for a new basic refractory brick manufacturing works at Gary, Ind., have been announced by General Refractories Co.

At the Gary Works, General will manufacture its complete line of chemically-bonded basic brick, as well as mortars, castables and other specialty products.

FIRMS SIGN AGREEMENT ON REMELTING PROCESS

▲ Midvale-Heppenstall Co. and Allegheny Ludlum Steel Corp. have completed an agreement for the sale by Allegheny Ludlum of technical knowledge and patent rights for the production of consumable electrode vacuum remelting of steel and ferrous group base alloys.

Under the terms of the agreement, Allegheny Ludlum is furnishing its know-how in consumable electrode vacuum remelting, furnace design, and production. The process will be the same as has been used in a new production department Allegheny Ludlum opened at Watervliet, N. Y., in 1955.

With the completion of the agreement Midvale-Heppenstall plans to proceed immediately to install production facilities to utilize the process.

PRODUCES TITANIUM METAL COMMERCIALLY

▲ First heat of titanium metal sponge at the new Ashtabula, Ohio, plant of Electro Metallurgical Co., Division of Union Carbide and Carbon Corp., was completed April 26. This heat produced by the sodium-reduction process marks the entry of Electromet into the titanium metal sponge field on a commercial scale.

The plant which has a capacity of about 7500 tons of titanium metal sponge a year is the largest built to date and was privately financed by the company. The new plant is located on the Lake Erie site of Electromet's plant for the production of ferro-alloys and calcium carbide at Ashtabula.

This is the first commercial production of titanium sponge in the United States by a method other than the magnesium-reduction process. In Electromet's process sodium is used to reduce titanium tetrachloride, resulting in metal of high quality. Economic and technological considerations led to the commercial development of the sodium reduction process, after extensive studies of other reduction methods. The company has had this process in operation on a pilot and prototype plant scale at its Metals Research and Development Laboratories in Niagara Falls, N. Y.

GAS MACHINERY AWARDED J&L FURNACE CONTRACT

▲ Jones & Laughlin Steel Corp. has awarded a contract to the Gas Machinery Co. for the installation of a two-zone slot type tube upset furnace at the Aliquippa Works.

How to cut mill downtime due to bearing failures...

use A·B·K* bearings

Roll neck and slipper bearings made of A-B-K material often outwear metal bearings many times. Their ability to cushion impact loads without peening, scoring or heat-checking protects roller necks, housings and chucks. Simplicity of design and light weight speed installation. Can be lubricated with grease, oil or water *alone*. Ask our engineers to help you solve your specific problems.

- Wear longer
- Won't score or heat check
- Light in weight
- Cut lubricant costs
- Save power

A·B·K
LAMINATED
PHENOLIC BEARINGS

*A registered trade-mark of American Brake Shoe Company in the United States and of Joseph Robb & Company, Limited, in Canada.

Brake Shoe
AMERICAN BRAKEBLOK DIVISION
Detroit 9, Michigan
In Canada: Joseph Robb & Co., Ltd., Montreal, Quebec

SOAKING PIT COVER CONTROL

REMOTE CONTROLS

Operate cranes, remove pit covers, monitor motors, send warning signals, etc.

TROLLEYPHONES

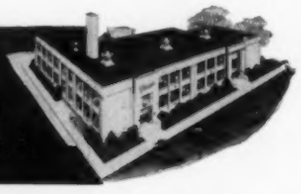
Voice communication between crane cabs and floor, mine locomotives and dispatcher.

AUDIOPHONES

Wired voice systems installed anywhere in industry. Common talking or selective.

Unique Femco control selects and operates up to 50 separate covers — automatically from a control panel in the soaking pit crane! Applicable to many different layouts and types of pits.

GET THE FACTS — SUBMIT YOUR PROBLEM FOR A PROPOSAL.



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IRWIN, PENNSYLVANIA
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Specialists in Electronic Communication and Automation

Use like a pencil . . . a complete line for every application. Marks are weatherproof, fadeproof, permanent.

Cold Markal Paintstik for surfaces 50° to 150°F.
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Consult our Engineering Service on marking problems . . . no obligation.

Send for catalog.

The Mark of Quality
MARKAL COMPANY 3087 West Carroll Avenue, Chicago 12, Illinois

TO EXPAND TITANIUM PROCESSING FACILITIES

▲ Crucible Steel Co. of America and its affiliate, Rem-Cru Titanium, Inc., announced a joint $400,000 improvement program for increasing titanium processing facilities at Crucible's Park Works in Pittsburgh, Pa. The improvements are expected to double the plant's capacity for the rolling of titanium sheet.

Improvements include the installation of a continuous double row furnace for heating titanium slabs, the erection of a new building to house a bar yard and auxiliary titanium processing equipment, and the remodeling of a sheet mill. The improved facilities will be used for titanium processing exclusively.

COMPANY FORMS NEW OPERATING SUBSIDIARY

▲ Formation of a new, wholly owned subsidiary has been announced by the S. Obermayer Co.

The new unit, Esso-Ramtite Co., has acquired property in Kentucky across the Ohio River from Portsmouth, and plant construction will start immediately. Esso-Ramtite will manufacture foundry facings and refractories.

Refractory production equipment now in the Chicago and Cincinnati plants of the S. Obermayer Co. will be transferred to the Kentucky plant and considerable additional equipment will be installed. Installation of equipment for the manufacture of foundry facings will follow completion of the refractory plant.

ENLARGED RESEARCH LAB NOW OPERATING

▲ A complete minerals processes laboratory has been placed in full operation by the Dwight-Lloyd Division of McDowell Co., Inc.

Facilities are for both unit processes and operations. Equipment permits crushing, sizing and screening, pelletizing, heat-hardening of pellets, sintering, blending of materials, strength analysis of processed minerals, drying and calcining, etc.

Meetings

▲ The 1956 Annual Meeting and exhibit of the Society for Experimental Stress Analysis will be held Oct. 31, Nov. 1 and 2 at Deshler-Hilton Hotel, Columbus, Ohio.

How Well Does Your Present Source Compare With National's COMPLETE Facilities For Motor and Generator Repair

Most motor repair shops can perform some of the operations listed below. Very few can handle them all. These are not routine operations, but extras which require expensive specialized equipment and experience. National service includes all 17 operations. How does your present repair source compare?

plus value operation	*available at National*	*at your present repair source*
1. redesigning and modernizing by competent engineers	yes	
2. vapor degreasing to insure good bonding of varnish	yes	
3. corncob blasting to prepare surfaces like new	yes	
4. rebuilding and remachining to standard of mechanical fits	yes	
5. temporary hotbanding to seat coils in slots	yes	
6. hot rerolling of permanent bands	yes	
7. grinding and polishing of journal shafts	yes	
8. vacuum impregnating	yes	
9. dynamic balancing	yes	
10. grinding and polishing of commutator at top operating speed	yes	
11. load testing	yes	
12. high frequency testing	yes	
13. electronic bar-to-bar and high sensitivity ductor testing	yes	
14. surge comparison testing	yes	
15. high potential ground testing	yes	
16. magniflux testing	yes	
17. anti-friction bearing inspection	yes	
Total	17	

If you can't answer "yes" for your present source on all 17 operations, you're taking unnecessary chances on getting less than the best repair work. You can't tell in advance on which jobs National equipment and National know-how will pay off in improved performance or longer life. So play it the one safe way — make National your first source for *all* motor and generator repairs.

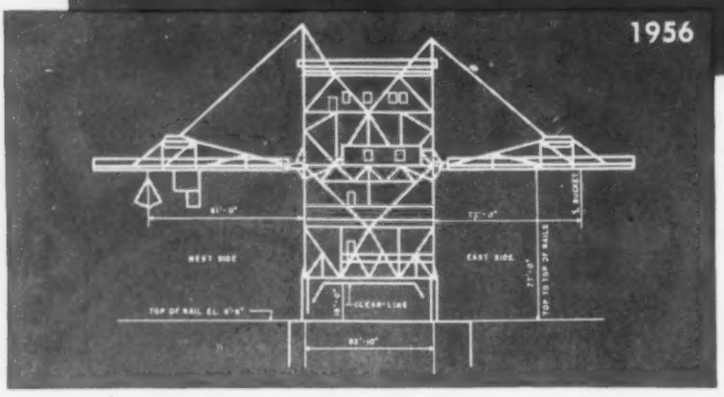
For more details on why the motor or generator you send to National will often come back better than new, call your nearby National field engineer today. Or drop us a line for his name and address.

NATIONAL ELECTRIC COIL COMPANY

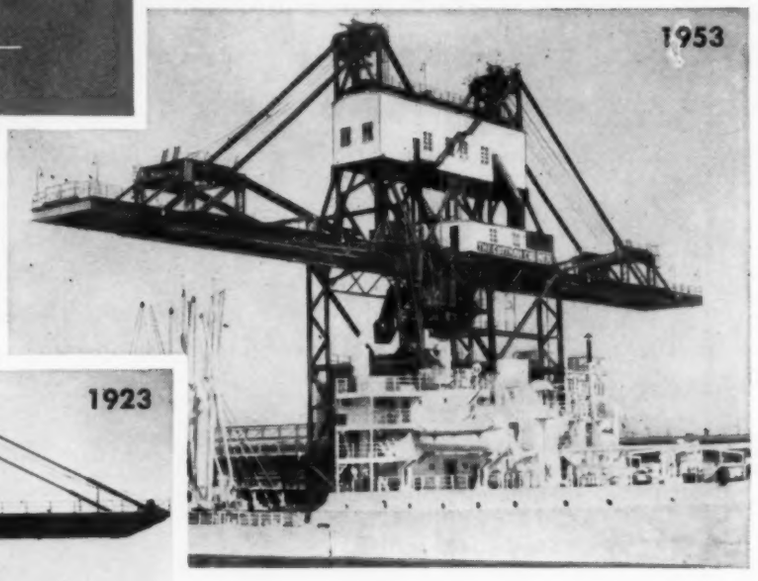
COLUMBUS 16, OHIO, U. S. A. TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

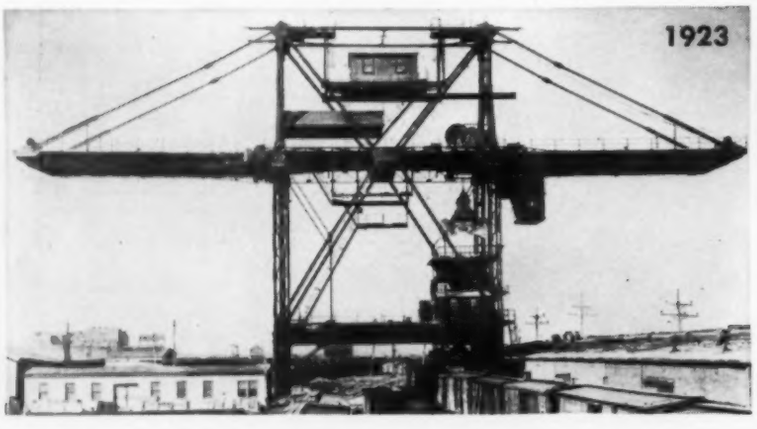
The Last 3 of 4 Boat Unloaders on the CANTON RAILROAD ORE PIER by HEYL & PATTERSON



No. 4 Boat Unloader by H & P, now being built, is almost a duplicate of the No. 3 Boat Unloader by H & P.

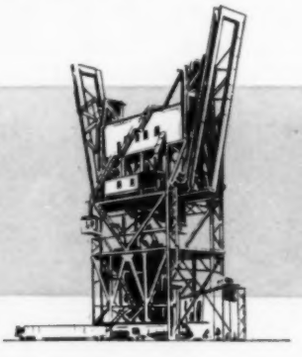


No. 3 Boat Unloader by H & P has been in operation since 1953.



No. 2 Boat Unloader by H & P has been operating since 1923 for The Cottman Company, Subsidiary of the Canton Co. of Baltimore, Md.

These three H & P unloaders located on the Canton Company Pier in Baltimore, are capable of unloading all kinds of ore directly into railroad cars or onto a high-line belt conveyor for remote loading into cars. All of these H & P unloaders are equipped with turntable trolleys to promote speedy cleanup, thus providing minimum turn-around time for both small and large carriers.



Heyl & Patterson INC.

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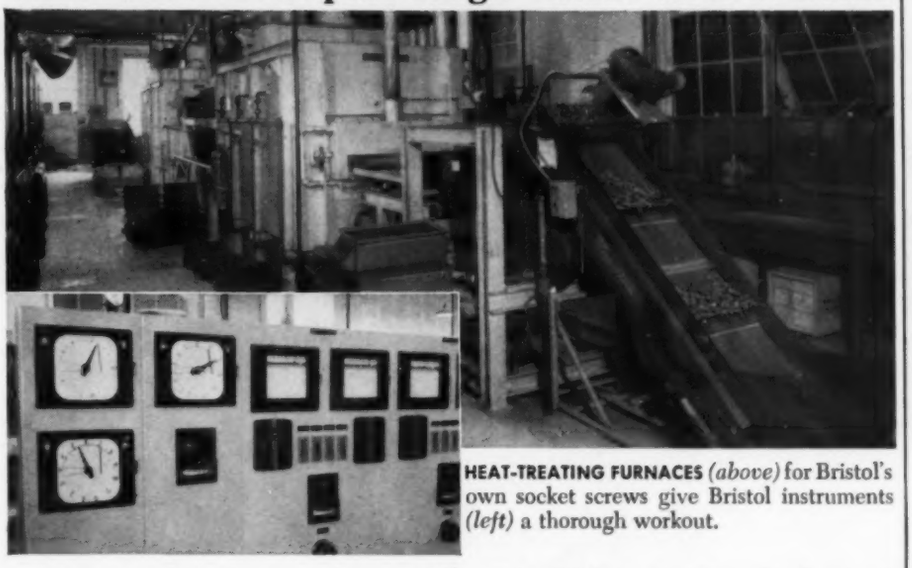
PHONE COurt 1-0750

BRISTOL'S

Instrumentation News

• News of instrumentation and automatic control in industrial heating and metallurgy •

New instruments pass tough "field" tests at home



HEAT-TREATING FURNACES *(above)* for Bristol's own socket screws give Bristol instruments *(left)* a thorough workout.

New Bristol instruments for metal-treating operations have a ready-made proving ground in Bristol's own socket screw manufacturing division.

Bristol instruments monitor and automatically control every phase of the Socket Screw Division's metal treatment—including a variety of continuous and batch-type furnaces, salt-baths, and tinning and degreasing operations for specialty products.

Completely automatic control assures highest quality and uniformity for Bristol socket screw products. New instruments get grueling "field" tests before they're released for general distribution. And, last but not least, visitors to the Waterbury plant can see Bristol instruments under actual load conditions.

Drop in, when you're in the New England area, and watch these precision instruments at work!

New control techniques cut fuel bills for metals

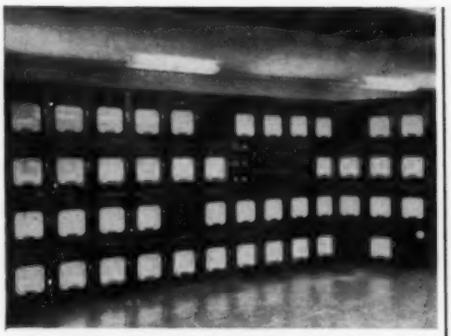
In 20 years, fuel required for ingot heating has dropped 50 to 60%.

A big share of the credit for this fuel economy goes to automatic control and instrumentation techniques developed recently. These new techniques, with better, faster, more accurate sensing and response, have chalked up significant savings, not only in fuel, but also in fixed charges, rolling time, and maintenance costs.

Probably most important for big savings is control of furnace temperature and atmosphere. Furnace pressure may be regulated by positioning the stack damper. Fuel-air ratio can be controlled by a valve in the air line. Air requirements for combined fuels may be totalized for better distribution of fuel throughout the plant.

Proper temperature-time sequences or "time cycles" also rack up big savings. Step heating sequences, differing for various metal ingots, no longer need be programmed by rule of thumb. Instead, any predetermined sequence of temperatures can be maintained automatically and easily changed to suit particular batches.

THESE BRISTOL ELECTRONIC AND AIR-OPERATED pyrometers automatically control regenerative soaking pits. Platinum, platinum-rhodium thermocouples at pit covers are sensing elements.



Telemetering helps control steel plant fuel

This Bristol telemetering installation helps U. S. Steel, Gary, Indiana, get the highest steel production with the lowest possible fuel cost.

The panel shows the amount of coke-oven and blast-furnace gas used throughout the plant as well as gas pressures at critical locations. With this complete supply and demand information at their fingertips, fuel dispatchers can control distribution for maximum efficiency and economy.

Precision rolling mill produces steel tapes 0.000125" thick

This precision cold-strip mill at The Arnold Engineering Company, Marengo, Illinois, rolls ultra-thin high-permeability strips for magnetic cores. The core strips may be as thin as 0.000125" and must be held to extremely close tolerances. To achieve the necessary precision, AccuRay gauges—employing Bristol Dynamaster recorders—measure thickness of material on both sides of the rolling mill. The AccuRay equipment is built by Industrial Nucleonics, Columbus, Ohio.

Want to apply these up-to-date control and instrumentation techniques to your industrial heating problem? Bristol engineers will be glad to talk over specific processes, problems, facts and figures with you. Write today to The Bristol Company, 123 Bristol Road, Waterbury, Conn.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

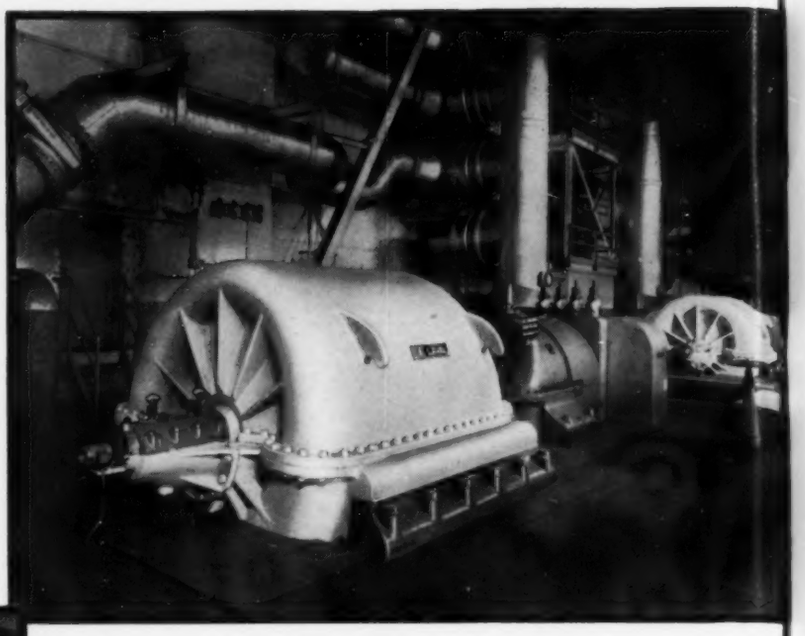
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

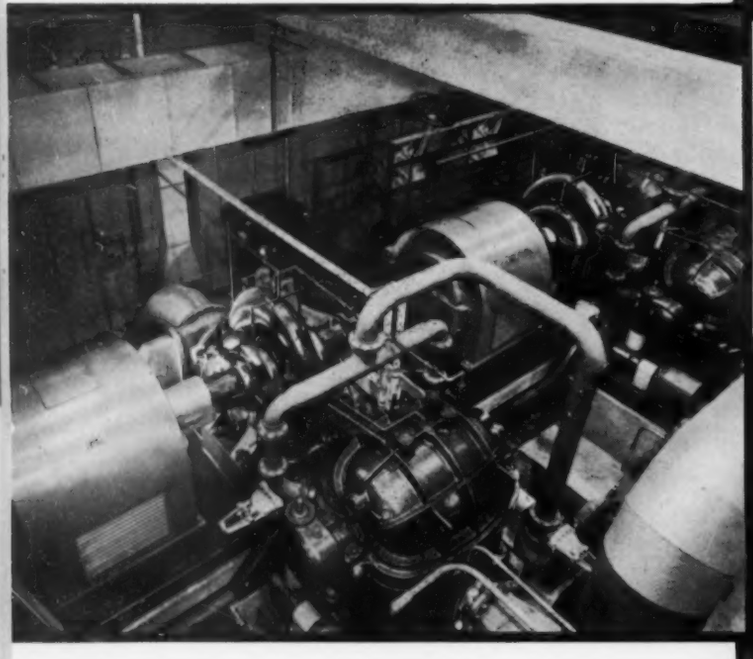
DE LAVAL
CENTRIFUGAL BLOWERS AND PUMPS

stay on the line for years at **Jones & Laughlin**

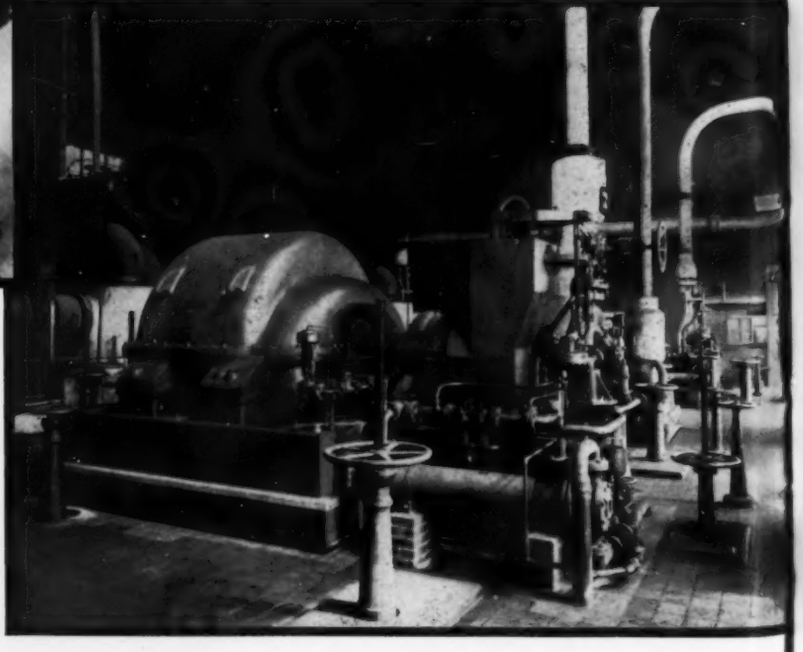
Jones & Laughlin reports: "*We have been using De Laval equipment for many years, and from our experience we have learned that De Laval blowers and pumps are inexpensive to maintain. Service is excellent. We can get spare parts quickly.*"

Three De Laval 22,000 gpm motor-driven pumps are on the job at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. These units are used to pump river water to the open hearth and general mill. Installed in October 1951, these three pumps "have not had any downtime at all since their installation except for periodic inspections," Jones & Laughlin reports.





These two De Laval centrifugal blowers, each rated at 100,000 cfm, are in use 24 hours per day, seven days per week except for a yearly inspection period. Since installation, there has been only 24 hours downtime in one of these blowers with a maintenance cost of about $400. "That's very little for this type of equipment," says the Jones & Laughlin blower room foreman.

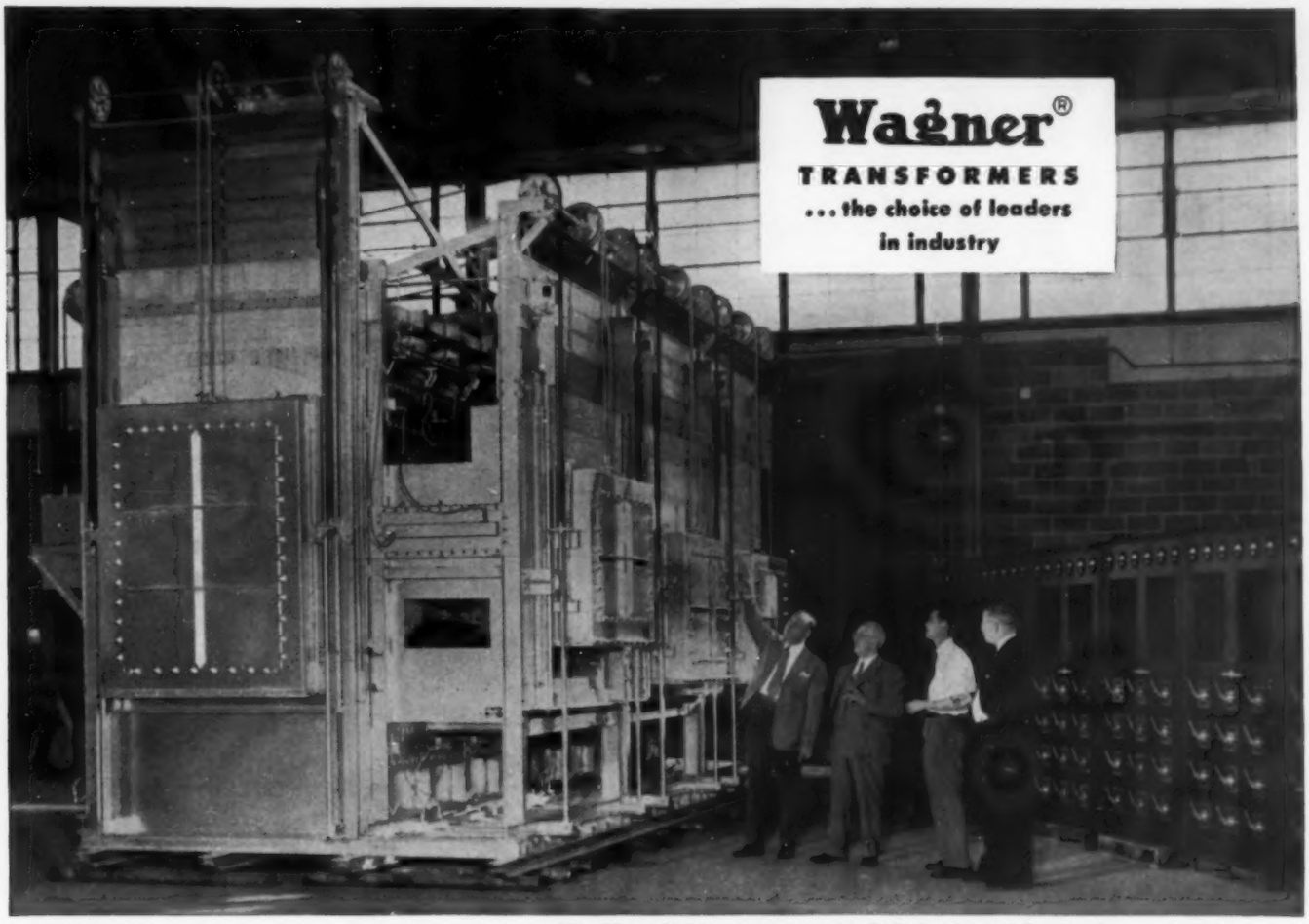


This is one of three De Laval gas exhausters, operating at 48,000 cfm around the clock. Two of these units can handle maximum capacity; the third is used as a spare. Jones & Laughlin says, "Without good gas exhausters you would have to 'bee hive' (open the top and permit the gas to go free), thus losing our by-product."

Send for Bulletin 0504

DE LAVAL *Pumps and Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey



This 55-ton high-temperature, controlled electric steel forging furnace, built by C. I. Hayes, Inc., gets its power supply through Wagner Dry-Type transformers.

Wagner Dry-Type Transformers supply power for the world's largest electric steel forging furnace

In North Grafton, Massachusetts, the Wyman-Gordon Company has placed in service the largest electric steel heating forging furnace ever built anywhere. It has a capacity of 10 tons of steel billets.

The plant, largest single unit in the USAF heavy press program, makes plane components of unprecedented strength, lightness and dimension on 50,000-ton, 35,000-ton and other hydraulic closed die forging presses.

Operating temperatures as high as 2400 degrees Fahrenheit may be maintained with a connected load of 600 kilowatts, supplied to the furnace through eight Wagner Dry-Type transformers.

Wagner Dry-Type transformers were selected for this job because they supply dependable power right at the load. You can spot them *close* to your loads and save money in terms of shorter runs of copper, reduced line losses, and lower installation expenses.

Wagner dry-type transformers for power distribution are available in single-phase, 1 through 500 kva; and three-phase, 3 through 2000 kva ratings. Write for Bulletin TU-57 or consult the nearest of our 32 branch offices.

Wagner Electric Corporation
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

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WT56-4

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INVESTED IN CORROSIVE FUME HANDLING

SEE HOW "BUFFALO" RUBBER-LINED EXHAUSTERS ARE DOING IT IN HUNDREDS OF PLANTS

Fumes from many processes destroy ordinary steel plate exhausters far earlier than normal life expectancy — and fan replacement is a major expense.

"Buffalo" Rubber-Lined Fans save you this expense. All exposed parts are protected by a layer of rubber "welded" permanently to the steel. *Corrosive fumes cannot contact the metal.* Small wonder these fans have stood up under the severest fume services anywhere from 3 to 12 times longer! Savings far more than pay for the cost of the rubber lining, to say nothing of reduction in down-time. It's just one more example of the "Q" Factor* that saves you money in all "Buffalo" Fans.

If you have fume exhausting installations, it will pay you to check fan replacement and down-time costs, and see how "Buffalo" Rubber-Lined Exhausters could be saving you money.

WRITE FOR BULLETIN 2424-F TODAY!

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

When the foot brake isn't enough

STOP CRANES SAFELY with EC&M

DYNAMIC BRAKING BRIDGE-STOP CONTROL

POSITIVE STOPPING by the same motors that drive the crane . . . even when power fails or overload relays trip.

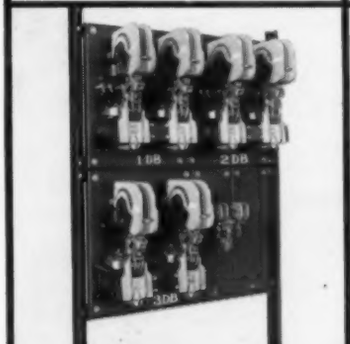
Now . . . collision between cranes, crashing into the end-bumpers, and wheel-sliding stops can be avoided by the use of simple equipment. Crane motors are automatically converted into self-excited generators by this EC&M Bridge-Stop Control to provide quick, positive stopping. Transition to dynamic braking occurs instantly on power failure or when overload relays trip. Braking is not dependent on an outside source of power.

This EC&M system of control is fast and equally effective when traveling in either direction. Graduated braking is maintained throughout the entire stopping period by a pulsating spring-closed contactor . . . an exclusive EC&M feature. On icy, slippery rails, wheels do not slide to a stop . . . instead, this system automatically releases and then re-applies retardation to give a quicker stop than when the wheels remain locked.

EC&M Dynamic Braking Bridge-Stop Control is easily applied to new and old cranes to provide power-failure emergency operation. It is also designed for service-braking operation which is selectively applied by the operator or end-zone limit switches.

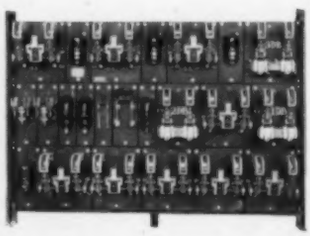
Eliminate hazards due to slippery rails . . . inability of operator to reach foot-brake in time when power fails.

Obtain smoother, safer operation when you change over to EC&M Dynamic Braking Bridge-Stop Control.



For existing installations, this panel provides graduated dynamic braking for quick, sure stops.

6149



Complete Duplex (2-motor) Controller including EC&M Dynamic Braking Bridge-Stop Control.

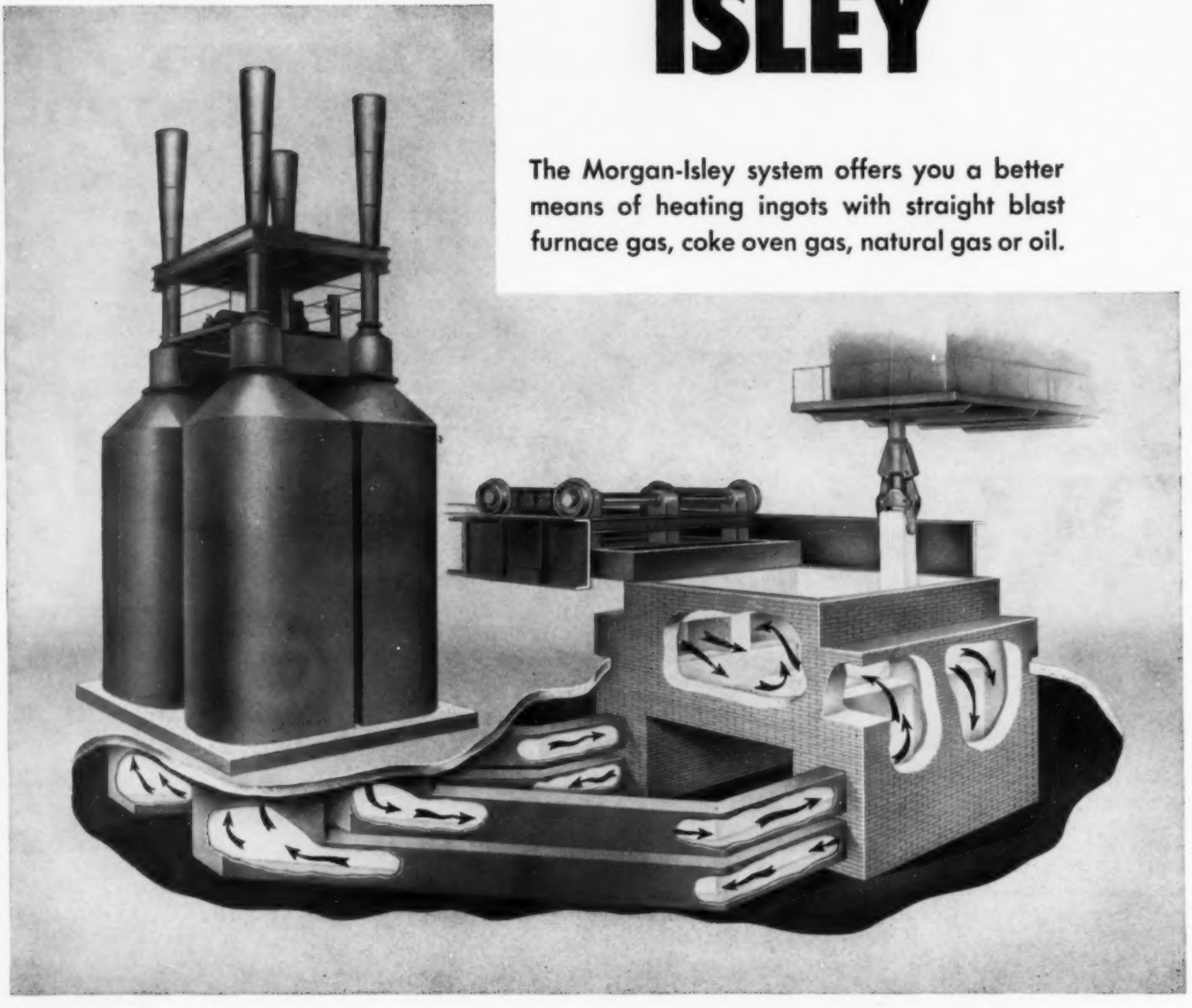
Write for Bulletin 921-6.0

SQUARE D COMPANY

EC & M DIVISION . CLEVELAND 28 OHIO

HEAT MORE STEEL with MORGAN-ISLEY

The Morgan-Isley system offers you a better means of heating ingots with straight blast furnace gas, coke oven gas, natural gas or oil.



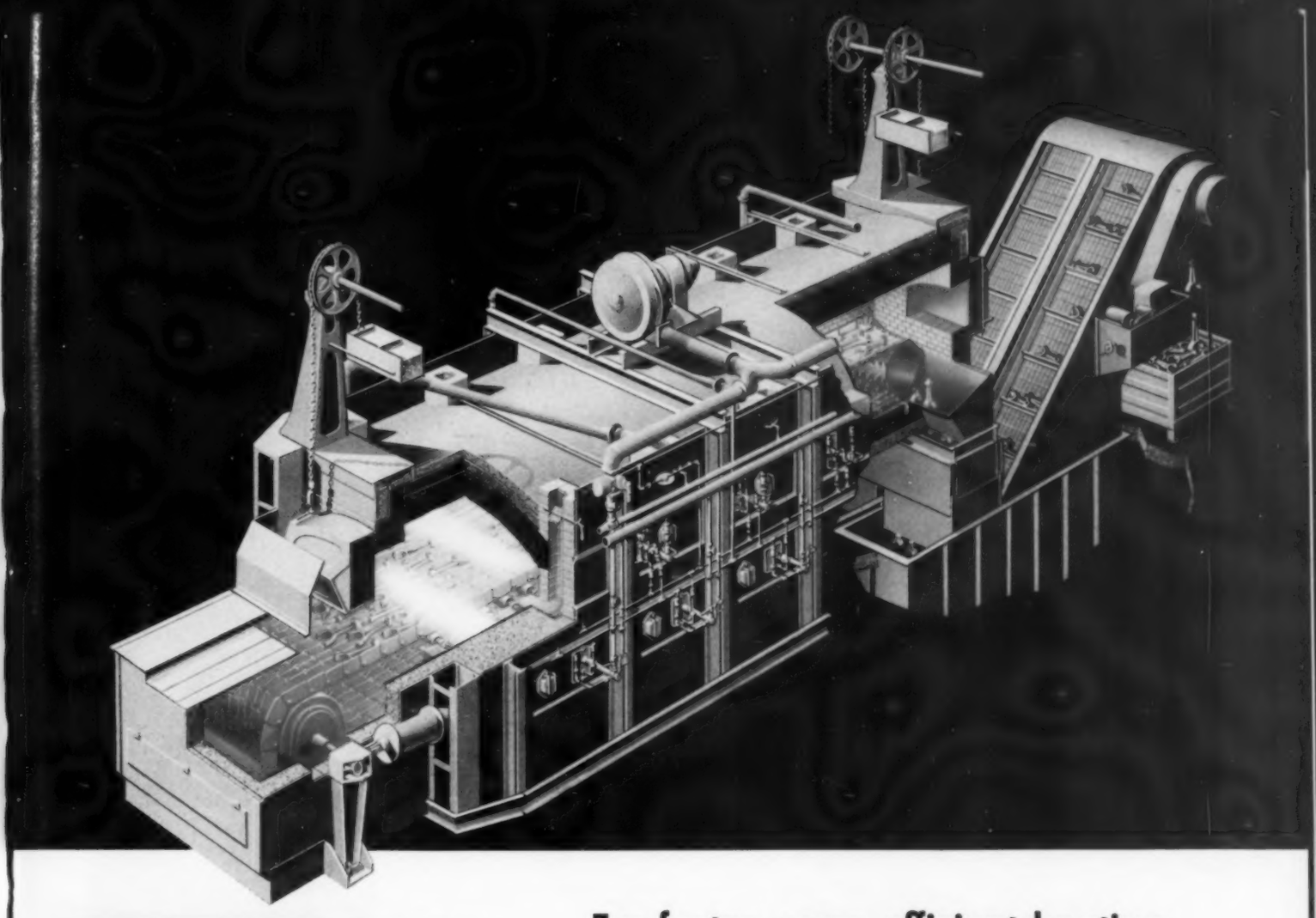
The schematic shows the flow of combustion air and flue gases through the regenerators and soaking pit. The Morgan-Isley system employs vertical regenerators. It eliminates regenerator capacity under the crane runway thus freeing this valuable area for heating steel.

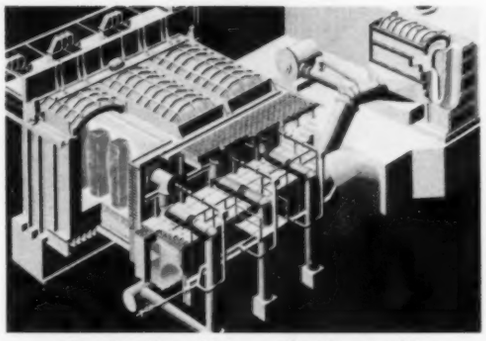
CCC-49

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

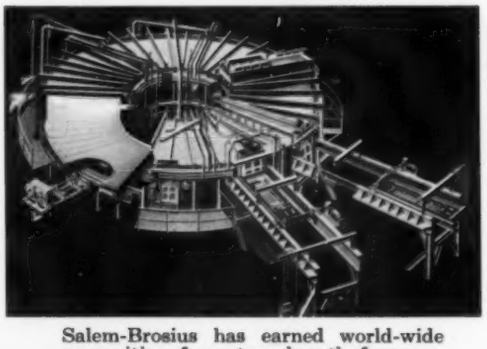
ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

H. H. Wood, Rep., Koppers Bldg., Pittsburgh, Pa. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, Eng.





Fast heating, high production soaking pits are a specialty of Salem-Brosius.



Salem-Brosius has earned world-wide recognition for rotary hearth furnaces.

For faster, more efficient heating or heat-treating furnaces, it pays to call on Salem-Brosius

Throughout the entire metals industry, Salem-Brosius designed furnaces are doing an efficient, low-cost job of heating and heat treating. The hardening furnace shown above in cut-away scale drawing is typical of high production heat treating furnaces by Salem-Brosius.

Gears, connecting rods, crankshafts and other critical forged parts are hardened in this type of furnace. Parts are heated to hardening temperature, soaked at this temperature for a controlled length of time and quenched—all automatically. Parts are also discharged automatically from the quench. This gas-fired, chain-belt, conveyor-type furnace is designed for high production, low maintenance and efficient operation—typical of all Salem-Brosius furnaces. Flexibility of time-temperature control reduces labor cost, assures product uniformity and permits variations of the heat-soak cycles.

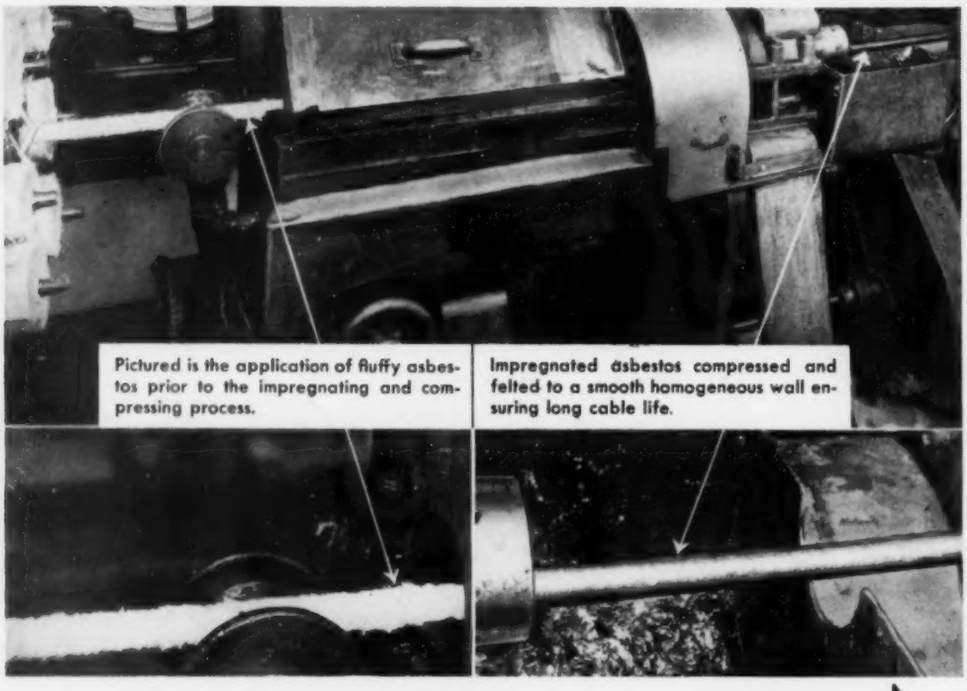
For any heat treating job—hardening, annealing, normalizing, aging, solution heat treating, and other forms—consult Salem-Brosius for the best in furnace equipment.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

IN CANADA: SALEM ENGINEERING LTD. — 1525 BLOOR STREET WEST, TORONTO 9, ONTARIO

seamless FELTED ASBESTOS walls add up to long range economical service



Pictured is the application of fluffy asbestos prior to the impregnating and compressing process.

Impregnated asbestos compressed and felted to a smooth homogeneous wall ensuring long cable life.

look beneath the braid

. . . that's where quality begins

Long lasting, trouble-free circuit performance depends on the materials and construction of wire and cables. And a look under the braid shows why Rockbestos A.V.C. (N.E.C. Type AVA) is built to give longer service.

The two seamless, dense felted asbestos walls, compressed and thoroughly impregnated with selected compounds, seal the varnished cambric from heat and moisture.

Dielectric strength stays high under high ambient temperatures. Heat dissipation is uniform. The felted wall construction protects the varnished cambric from rupture in the sharpest bends.

HERE'S HOW YOU BENEFIT*

Get high dielectric values from Varnished Cambric because of its controlled application over seamless felted asbestos walls.

HIGH DIELECTRIC STRENGTH — minimum breakdown voltages for 600 and 1000 volt power cables — 15 KV.

MOISTURE RESISTANCE — same minimum dielectric breakdown — wet or dry — 15 KV on 600 and 1000 volt power cables.

RUGGED CONSTRUCTION — minimum breakdowns after bending tests — 15 KV for 600 and 1000 volt power cables all sizes.

CONTROLLED QUALITY — materials and workmanship and performance under rigid Quality Control.

CUTS MAINTENANCE COSTS — It won't bake brittle, crack or flow in high ambients . . . won't deteriorate with age, or rot when exposed to oil, grease or fumes.

The result: wire failures are eliminated; maintenance costs are held down; plant and equipment operation maintained at top level.

*Write for the test and construction specifications of Rockbestos A.V.C. (N.E.C. Type AVA) available in the new booklet, "Specification RSS-88."

STOCKED COAST TO COAST
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONNECTICUT

NEW YORK CLEVELAND • DETROIT • CHICAGO • PITTSBURGH • ST. LOUIS • LOS ANGELES • NEW ORLEANS
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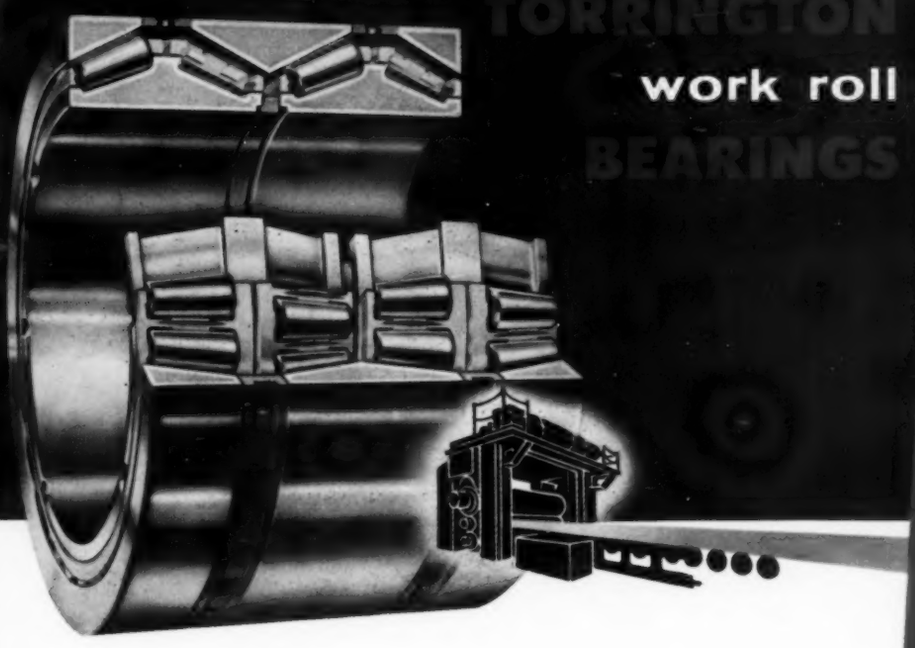
roll higher tonnage records with TORRINGTON work roll BEARINGS



TORRINGTON WORK ROLL BEARINGS are helping to set new tonnage records wherever they are used. And why not! They're designed and built to do just that. Every detail of construction from the electric furnace steel used in their construction to the precision-ground races and rollers work to one objective: to provide the steel industry with the finest bearings possible for long, heavy-duty service. Keep your production rolling to new records. Both two-row and four-row types of TORRINGTON WORK ROLL BEARINGS are standard in a wide variety of sizes. Next time make it TORRINGTON. There's none better.

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Needle • Ball • Needle Rollers

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One unit of our expansion program
Tunnel Kiln Building, Taylor Works

An extensive expansion and improvement program is under way at our Taylor, Ky., and also at our Cincinnati works.

An additional tunnel kiln, continuous dryers, new grinding, screening and batching equipment are parts of the plan for the Kentucky works.

These expansion projects will result in some temporary delays but better days are ahead! By mid-summer you will benefit in shorter delivery on Taylor-Made Refractories, produced under the most modern conditions of quality control.

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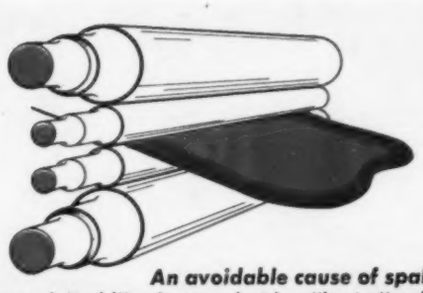
TIPS FROM A ROLL MAKER'S NOTEBOOK

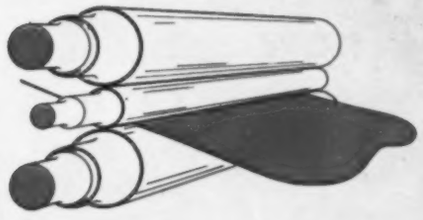
MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

How to get longer life from plate mill work rolls



An avoidable cause of spalling: Uncropped "cold" edges and sides "bruise" rolls by causing over-stressing at the edges. Sub-surface fatigue cracks develop in these areas and roll starts to spall.

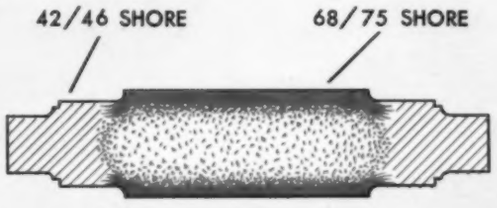


Some strength can be "swapped" for extra wear resistance in the middle roll of a 3-high mill, which gets approximately three times as much wear as the top and bottom rolls.

In plate mill work rolls, the balance of strength-vs.-hardness varies with the type of mill, the stand, and the rolling stresses involved. In general, however, the harder the rolls, the better.

This is particularly true of the work rolls in a 4-high mill and of the middle roll in a 3-high mill when used for finishing passes. On the other hand, the absence of grinding facilities in some plants often puts a limit on hardness, since the rolls must be soft enough to machine.

Spalling and fire cracking – With the many suitable combinations of mechanical properties available today, the life expectancy of a cast iron plate mill work roll depends largely on its resistance to fire cracking and spalling. And the current demand for good plate finish has placed even more emphasis on roll surface condition.



Triple-poured Nironite "F" roll, showing hardness ranges for the roll surface and the neck.

Three kinds of iron in a single roll – Mack-Hemp metallurgists have answered all these requirements in the *Nironite "F"* roll, a high-alloy grain-type roll.

Nironite "F" rolls are always double-poured, and sometimes even triple-poured. The deep outer shell is nickel-chromium alloy iron—very hard, very dense, and highly resistant to fire cracking. The second metal, a soft gray iron, provides the strength and resistance to impact needed in the core. Finally, the necks of all large Mack-Hemp plate mill rolls are cast with a third alloy whose carbon content is closely controlled. This third pour eliminates the tendency to weakness and coarse grain structure often encountered in the necks of double-poured plate mill rolls (a result of the slow cooling rate of the large mass of metal in the necks). It provides increased strength and a fine grain structure that prolongs the life of the roll neck bearings.

Another Nironite grade—*Nironite A*—is also widely used for work rolls in many plate mills. A single-poured cast iron grain roll of slightly lower alloy content than the iron of the first pour in Nironite "F" rolls, it provides excellent strength properties at somewhat lower hardness levels.

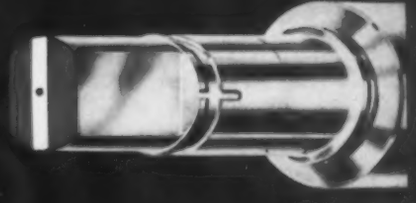
No matter what type of rolling you do . . . ferrous or non-ferrous . . . Mack-Hemp roll engineers and metallurgists can help you with your special problem. Simply write Mackintosh-Hemphill Division, E. W. Bliss Company, 901 Bingham Street, Pittsburgh 3, Pa.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



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electrode end-caps!

National Carbon's new protective end-caps perform a dual function. They screen out dust and dirt from electrode socket... protect against end-face chipping—two common causes of impaired electrical performance. They also give better visibility, quicker identification, easier handling and storage of graphite electrodes from 12-24 inch diameter. National Carbon's new electrode sales and service program serves you in many ways:

HERE'S HOW:

Product Quality: Recognized as the industry's highest.

Technical Service: Largest, best qualified group of its kind... organized to extend the service function regularly furnished by field salesmen. Repeatedly, this service has recommended improvements in electrode operation...improvements which have resulted in more efficient power utilization, better joints and joining procedure, and attractive dollar savings for customers.

Free Electrode Training Program: Conducted in your own plant or any other mutually convenient location. Streamlined demonstration program familiarizes your men with the important *do's* and *don't's* of electrode usage.

FOR ELECTRODES AND ELECTRODE SERVICE . . . RELY ON NATIONAL CARBON COMPANY

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Personnel News...

J. H. Elliott has been named assistant executive vice president, operations of United States Steel Corp., and **E. H. Gott** succeeds Mr. Elliott as vice president, operations-steel. At the same time it was announced that **Oscar Pearson,** formerly general superintendent of the corporation's South Works, Chicago, succeeds Mr. Gott as general manager of operations. **A. J. Berdis,** formerly general superintendent of Fairless Works, becomes general superintendent of South Works, and **E. B. Speer,** assistant general superintendent of Fairless Works, becomes general superintendent there.

Mr. Elliott joined U. S. Steel in 1917 at Homestead Works. In 1937 he was made a division superintendent of Irvin Works and became general superintendent of the plant in 1950. That year he was made assistant general manager of operations of U. S. Steel, and in 1951 general manager-manufacturing. In 1953 he was appointed vice president, operations-steel.

Mr. Gott joined U. S. Steel at Ohio Works in Youngstown in 1937. He was transferred to Clairton Works in 1939 and to Gary Steel Works in 1941, becoming assistant division superintendent of service departments. In 1949 he was made assistant general superintendent of the South Works in Chicago, and in 1951 he was appointed general superintendent of the Youngstown district operations of U. S. Steel. He was promoted to general manager, operations-steel in 1953.

Mr. Pearson came to the corporation's Tennessee Coal & Iron Division in 1928. Transferring to Gary Works in 1941 he was later advanced to chief metallurgist. He was appointed division superintendent of steel production at Gary in 1950 and in 1952 was named assistant general superintendent at Duquesne, Pa., Works. He was made assistant general superintendent of Youngstown District Works in 1953 and general superintendent of South Works, Chicago, in 1954.

Mr. Berdis joined U. S. Steel in 1929 in the Gary Sheet and Tin Mill. He was transferred to Pittsburgh in 1935 to become chief design engineer for the construction of Irvin Works and later served as chief engineer of the plant. He was made general superintendent of the corporation's plant at Vandergrift in 1947 and returned to Irvin Works in 1950 as assistant general superintendent. He was named general superintendent of Fairless Works in 1951.

Mr. Speer joined U. S. Steel in 1938 at Youngstown District Works. He was transferred to U. S. Steel's Gary Works as assistant division superintendent of steel production, and was appointed division superintendent of steel production there in 1952. A year later he came to Duquesne Works as assistant general superintendent. He was made assistant general superintendent of Fairless Works in 1955.

George B. Schierberg was elected president and treasurer of Granite City Steel Co. and **N. P. Veeder** was elected executive vice-president. Mr. Schierberg succeeds **John N. Marshall** as president. Mr. Marshall was elected chief executive officer of the company and re-elected chairman of the board of directors, a position he has held since 1949.

Paul C. Ziegler, manager of the Cleveland plant of the Steel and Tubes Division of Republic Steel Corp. will succeed **Charles H. Reinert** as manager of the division. Mr. Reinert will continue with the company as a consultant. Mr. Ziegler came to Republic in 1933. In 1943 he was named assistant superintendent of the Cleveland plant. Three years later he was appointed superintendent of the Ferndale, Mich. plant and in 1948 became manager of the Cleveland plant, the position he held at the time of his current appointment.

L. S. Mobley has been named to succeed **Roy E. Brakeman** as chief engineer of the Southern Steel District of Republic Steel Corp. Mr. Brakeman, who is retiring will continue as consulting engineer at the company's Gadsden, Ala., plant. Mr. Mobley transferred to Gadsden from Republic's plant in Warren, Ohio in 1955 as a mechanical engineer. He was promoted to assistant chief engineer last October. Mr. Brakeman came to Gadsden in 1932 as chief engineer of Gulf States Steel Co. and retained that post when Republic acquired the plant in 1937. Mr. Brakeman started with Garrett-Cromwell Engineering Co. He

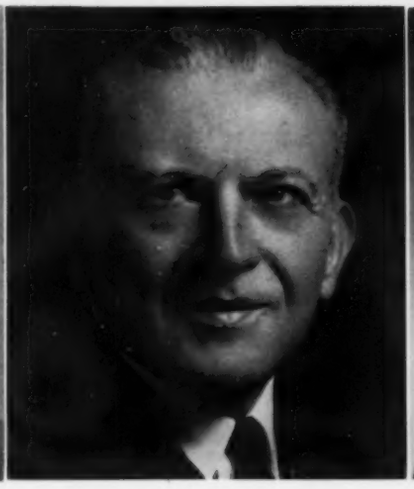
J. H. ELLIOTT

E. H. GOTT

GEORGE B. SCHIERBERG

N. P. VEEDER

L. S. MOBLEY



EDGAR C. BAIN

J. B. AUSTIN

M. W. LIGHTNER

later worked at the South Works of Illinois Steel Co. in South Chicago and at the Lackawanna Steel plant in Buffalo. Mr. Brakeman was chief engineer for TCI when he left Birmingham in 1921 to become chief engineer of Otis Steel Co. in Cleveland. He later returned to the South as chief engineer for Woodward Iron Co., and remained with Woodward until his transfer to Gadsden in 1932.

Edgar C. Bain has been promoted to assistant executive vice president-operations, U. S. Steel Corp. **J. B. Austin** was named vice president, fundamental research, and **M. W. Lightner,** vice president, applied research. Dr. Bain has served successively as metallurgist for General Electric Co., Atlas Steel Corp., and Union Carbide and Carbon Co. He joined the research staff of U. S. Steel in 1928 at the Kearny, N. J., laboratories and was named assistant to the vice president of the corporation in 1935. He was named vice president—research and technology in 1943. Dr. Austin became associated with the research laboratory of the corporation in Kearny, N. J., when it was established late in 1928, as a physical chemist. He was made assistant director of the laboratory in 1944 and two years later director of research. Mr. Lightner joined U. S. Steel as assistant to the chief metallurgist at Homestead District Works in 1933. He became chief metallurgist in 1937 and assistant to the general superintendent at Homestead in 1940. In 1942 he joined Heppenstall Co. in an executive capacity, returning to U. S. Steel in 1944. He was named assistant vice president, applied research and development, in 1954.

George I. Seybold has been elected a vice president of the Rust Engineering Co. He had formerly served as vice president and assistant general manager of Chemical Construction Corp.

Carl G. Hogberg was named assistant vice president of Michigan Limestone Division, U. S. Steel Corp. He was previously assistant to the vice president.

James F. Miller, formerly manager of operations, Production Department, Brackenridge Works of Allegheny Ludlum Steel Corp., has joined Titanium Metals Corp. of America. Mr. Miller joined Allegheny Ludlum in 1931 as an engineer. He became assistant superintendent of the blooming and strip mill in 1932, and was named sheet mill foreman in 1934. He was named plant engineer in 1946 and in 1949 he became assistant plant manager and later manager of operations.

Glen J. Hartman was appointed manager of operations of Ohio Seamless Tube Division of Copperweld Steel Co. He succeeds **Raymond E. Dewey,** who has resigned to accept a position with another firm. Mr. Hartman has served as assistant manager

GLEN J. HARTMAN

of operations since May 1, 1955. He began his career with the division as a chemist in 1941, and in 1954 became the plant metallurgist.

John W. Harsch, director of engineering, Leeds & Northrup Co.; **William C. Dunn,** chairman of the board, Ohio Crankshaft Co.; **Osgood J. Whittemore, Jr.,** research ceramic engineer, Norton Co.; and **Ernest G. de Coriolis,** for 30 years the director of research and development, Surface Combustion Corp. have been awarded the 1956 Trinks Industrial Heating Award. Bestowed annually by a judges' panel of industrial heating authorities, the award is named

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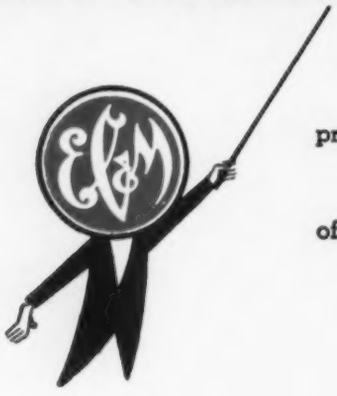

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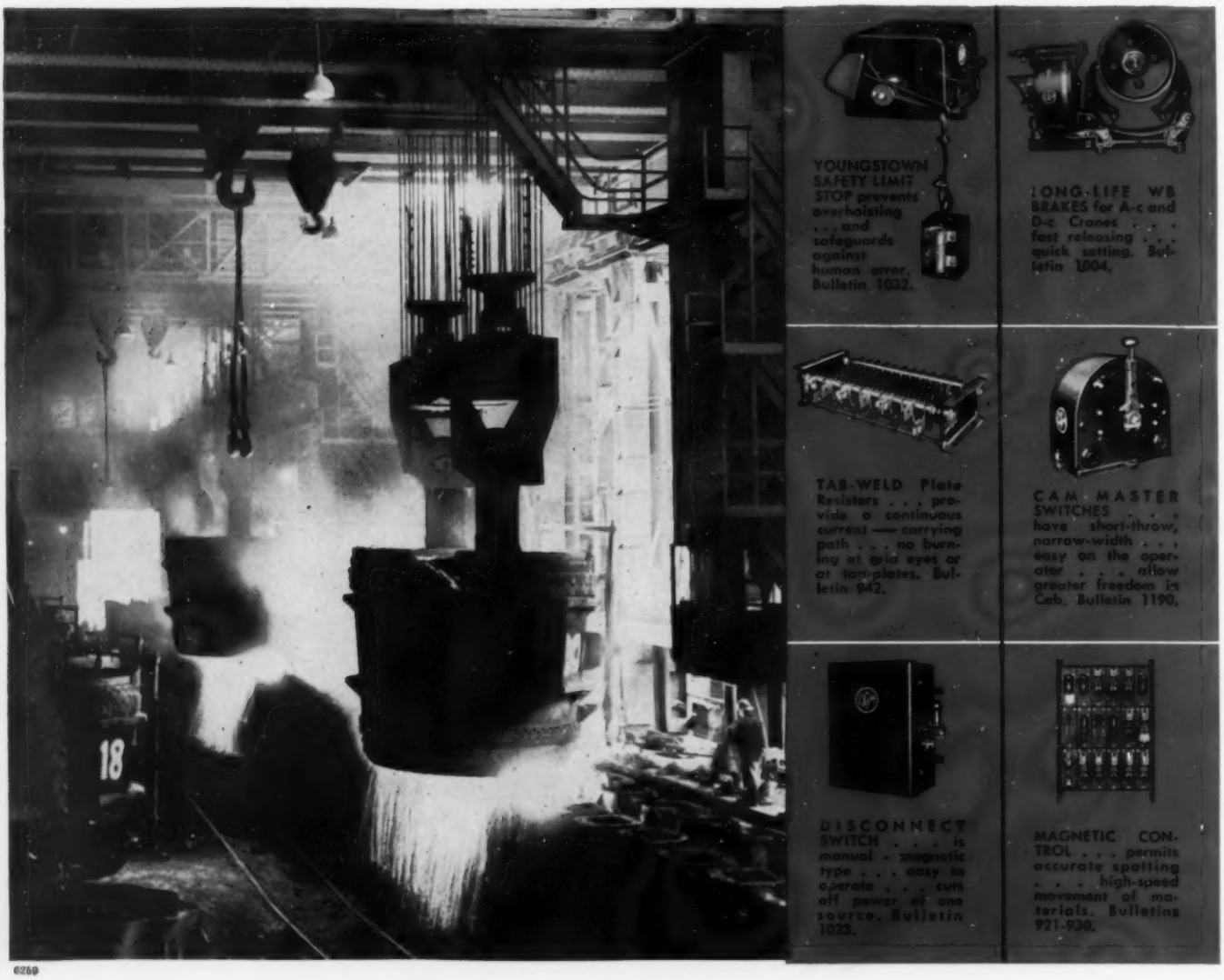
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YOUNGSTOWN SAFETY LIMIT STOP prevents overhoisting . . . and safeguards against human error. Bulletin 1032.
LONG-LIFE WB BRAKES for A-c and D-c Cranes . . . fast releasing . . . quick setting. Bulletin 1004.
TAB-WELD Plate Resistors . . . provide a continuous current — carrying path . . . no burning at grid eyes or at tap-plates. Bulletin 942.
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DISCONNECT SWITCH . . . is manual - magnetic type . . . easy to operate . . . cuts off power at one source. Bulletin 1023.
MAGNETIC CONTROL . . . permits accurate spotting . . . high-speed movement of materials. Bulletins 921-930.

6259

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DON S. HOLSTEIN

ORA E. CLARK

W. F. LENT

R. A. MILLERMASTER

after **Willibald Trinks,** professor emeritus of Carnegie Institute of Technology, a member of the panel, first recipient of the award, and world authority on industrial heating problems.

Don S. Holstein, former general superintendent in charge of rolling, processing, and maintenance operations at the Middletown Works, Armco Steel Corp., has been named assistant manager there. **Ora E. Clark** has been appointed general superintendent of all operations at Middletown Works. He was formerly general superintendent of melting operations. **Donald C. Osborne,** on special assignment for the past year, has been appointed assistant to the general superintendent. **Forest M. Morrow,** who has been on a consulting assignment assisting other steel companies who have licensed Armco's patented continuous coating process, has been named area superintendent of the West Processing, stainless, and coating departments.

W. F. Lent was named vice president in charge of manufacturing of Cutler-Hammer, Inc., and **R. A. Millermaster** was named vice president in charge of development. Mr. Lent began his career at Cutler-Hammer as an application engineer and in successive appointments was named manager at the firm's molding department and later production manager. In 1950, he became works manager and held that position until his present appointment. Mr. Millermaster joined the company as test engineer in 1927. In 1933, he was named development supervisor, assistant manager of development in 1948, and in 1952, manager of development.

Alfred A. Augustine was appointed chief engineer of Loftus Engineering Corp.

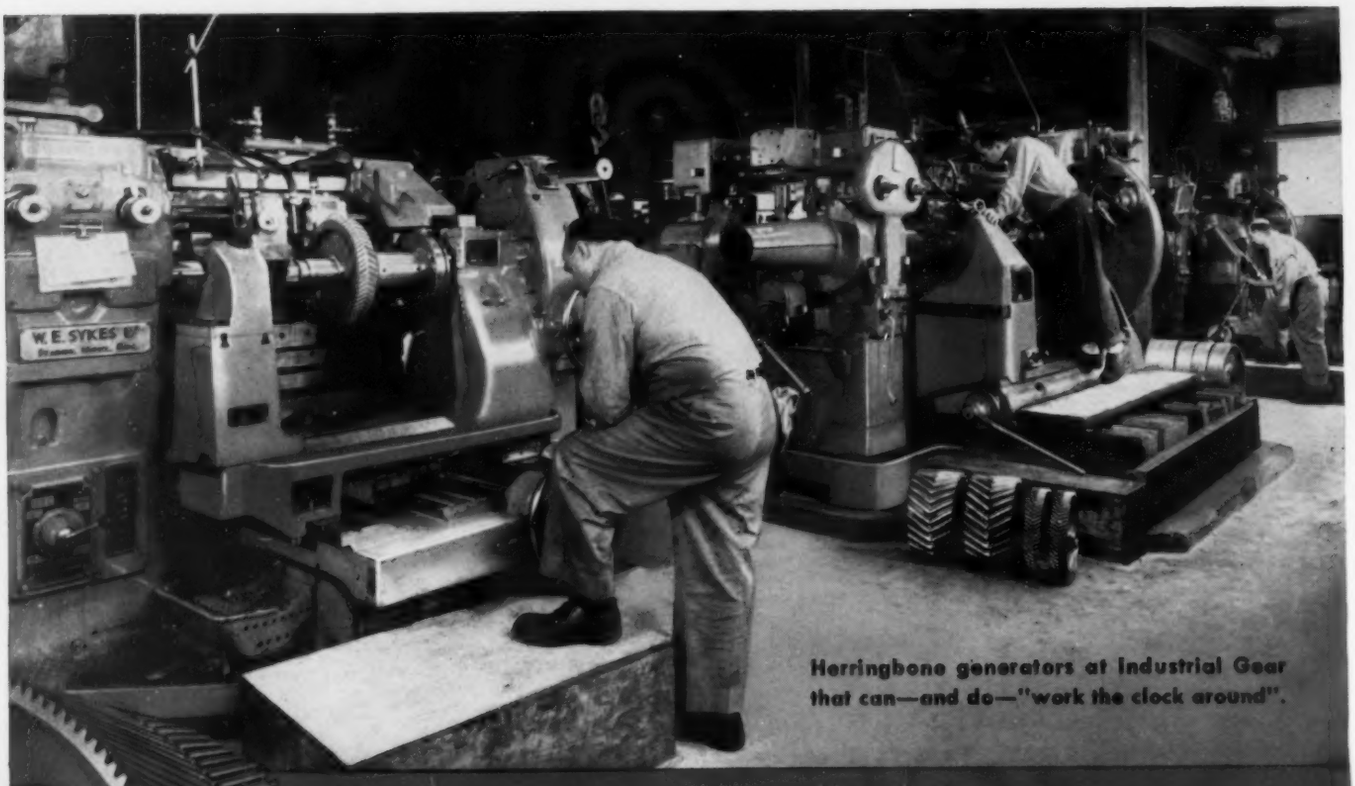
Evan E. Engle has been promoted to general foreman of the annealing department of the cold strip mill at Republic Steel Corp.'s Warren District.

Philip Scarola has been named sales manager, and **Charles R. Steen,** manager of engineering of Elliott Co.'s Crocker-Wheeler Motor Division. Mr. Scarola, who was formerly manager of d-c application engineering, joined the company in 1942 as a field service engineer. From 1948 to 1954 he was, a sales engineer in the Pittsburgh district office. He was also in the company's Industry Engineering Department. Mr. Steen came with Elliott in 1954 as manager of d-c engineering.

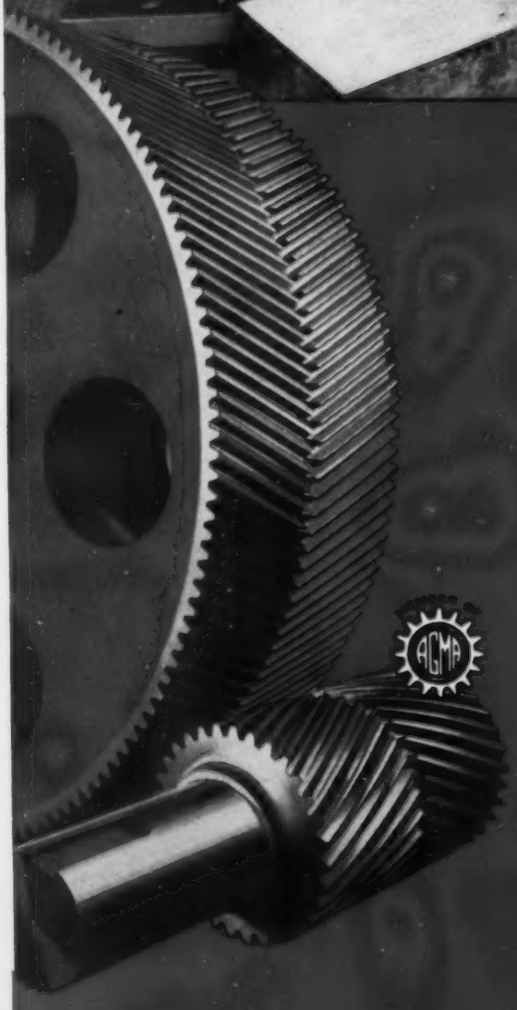
PHILIP SCAROLA

CHARLES R. STEEN

G. W. Bowman, formerly district manager, Industrial Division, of Harnischfeger Corp.'s Cleveland



Herringbone generators at Industrial Gear that can—and do—"work the clock around".



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office, was appointed sales manager of this company's Hoist Division. **F. A. Liebich,** who previously was in charge of Harnischfeger's Canadian operations, succeeds Mr. Bowman as district manager at Cleveland.

G. W. BOWMAN

F. A. LIEBICH

H. D. McLeese has been elected a vice president of Metal & Thermit Corp. Mr. McLeese, who was named general sales manager of Metal & Thermit in May, 1955, will continue as the Company's chief sales executive.

S. J. Moran was named vice president and general manager of Blaw-Knox Co.'s Foundry and Mill Machinery Operations, and **E. C. Rook** was appointed vice president and general manager of Fabricated Products Operations. Formation of Foundry and Mill Machinery Operations brings together under Mr. Moran five former divisions operating eight plants. Fabricated Products Operations under Mr. Rook unites five divisions operating five plants and auxiliary facilities. In addition, **W. C. Berg, Jr.** has been named assistant to the vice president and general sales manager of Blaw-Knox Co. Formerly roll sales engineer, Mr. Berg joined the Continental Foundry & Machine Division of the company in 1952.

Marquis P. Orr has been appointed assistant manager of roll sales for E. W. Bliss Co.'s Mackintosh-Hemphill Division. Mr. Orr came to Mackintosh-Hemphill in 1941. In 1946 he entered the company's sales department, and in 1952 he was made a roll engineer.

William E. Shenk has been appointed director of electrical engineering of the McKay Machine Co. at the same time **Richard C. Davidson** was named chief electrical engineer.

John Wilkinson has been named works manager of Blaw-Knox Co.'s Lewis Machinery Plant. **Henry Krack** assumes the duties of assistant works manager. Mr. Wilkinson started in 1935 as a metallurgical observer for Crucible Steel Co. of America. In 1937 he was appointed general foreman, Bar and Finishing Mills, Carnegie-Illinois Steel Corp. His next assignment in 1947 was general superintendent, Aceros Nacionales in Mexico City. In 1948 he joined Lewis as assistant to the vice president-general manager. Mr. Krack has been with Lewis since 1929. In 1940 he was named machine shop foreman, and three years later, acting chief industrial engineer. In 1950 he was appointed chief inspector.

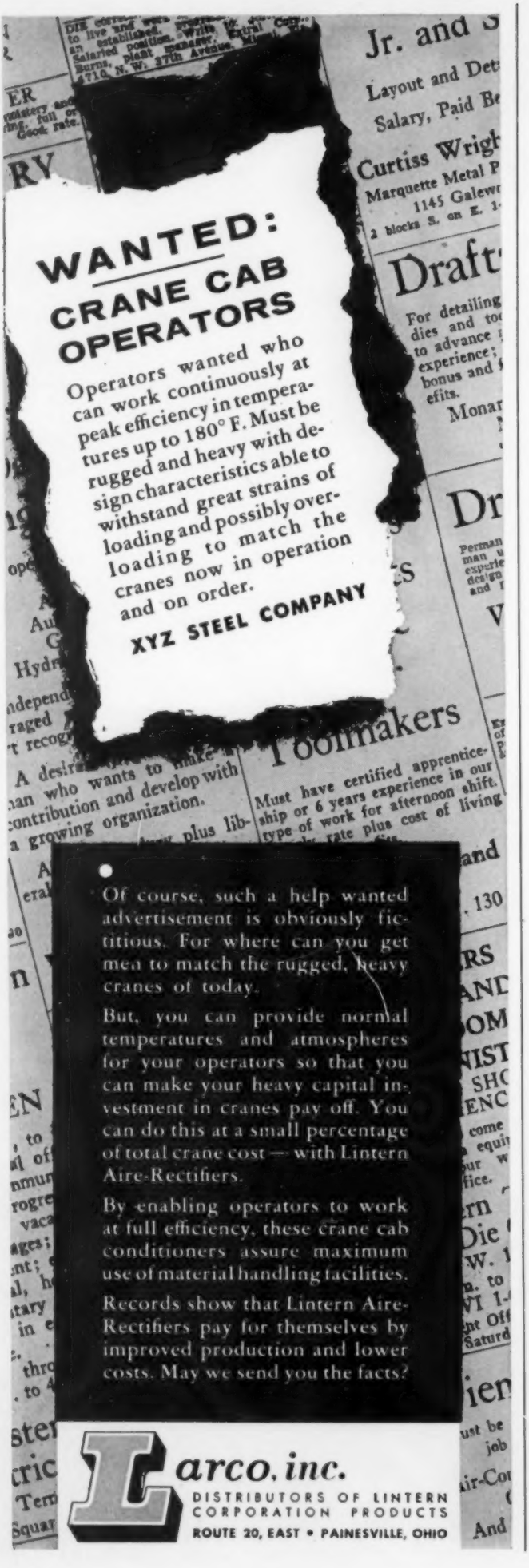
R. O. Peterson has been elected vice president, Brush Division-Engineering of the Osborn Manufacturing Co. He has been associated with Osborn since 1936, when he joined the organization as manager of its Technical Department.

H. D. McLEESE

S. J. MORAN

W. C. BERG

MARQUIS P. ORR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Operators wanted who can work continuously at peak efficiency in temperatures up to 180° F. Must be rugged and heavy with design characteristics able to withstand great strains of loading and possibly overloading to match the cranes now in operation and on order.
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But, you can provide normal temperatures and atmospheres for your operators so that you can make your heavy capital investment in cranes pay off. You can do this at a small percentage of total crane cost — with Lintern Aire-Rectifiers.
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H. N. Muller, Jr., has been appointed chief engineer of the Canadian Westinghouse Co., Ltd. Mr. Muller was formerly assistant to the vice president, apparatus products, of the Westinghouse Electric Corp.

P. C. Ford is the newly appointed executive engineer of Wagner Electric Corp. He was formerly chief engineer, Electrical Division.

Neil E. Firestone has been named manager of General Electric Co.'s Manufacturing Operations Service. He succeeds **John S. Macdonald,** who recently was named general manager of G-E's Distribution Assemblies Department. **Armand V. Feigenbaum** has been named manager of Quality Control Service, a newly established component in Manufacturing Services.

Thomas M. Nourse has been appointed Pittsburgh district sales manager for Hagan Corp. He replaces **John E. Duesing** who is now national sales manager of the controls division of Hagan. Formerly Mr. Nourse was a sales engineer at the Chicago district office.

Obituaries

Gordon Fox, retired vice president of the Freyn Dept., Koppers Co., Inc., died June 6. He was 69. Following graduation from University of Wisconsin, Mr. Fox served as sales engineer for General Electric Co., and as electrical design engineer for Steel and Tubes

GORDON FOX

Corp., of America, at Indiana Harbor, Ind. He later joined Freyn and Brassert, and as a member of that organization worked in Russia from 1928 through 1933. He was the author of several books and many articles on steel plant electrification. He was active in AISE affairs and served a number of years as Chicago district secretary.

Harvey B. Mann, the founder of Mann Engineering Co., died May 19.

Nils A. Resare, chief design engineer, Inland Steel Co., East Chicago, Ind., died May 18.

John L. Bowling, superintendent, cold mill, Great Lakes Steel Corp., Ecorse, Mich., died June 13.

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Teamed For Quality...Service...Progress

Two steelmakers, each known for its achievements in its own particular field of producing forged and annular rolled products are now combined to supply requirements of the largest and smallest. Two groups of production and research engineers are joined to better serve American industry. The new company is a totally owned subsidiary of Heppenstall and will operate independently. Each company will continue to offer American industry the custom made products for which it is famous.

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GENERAL ELECTRIC *Control*

For fast, accurate performance, low operating costs, specify General Electric d-c control for your crane

If you're looking for the ultimate in crane control—from high-speed lowering to pin-point spotting, you want General Electric d-c crane control!

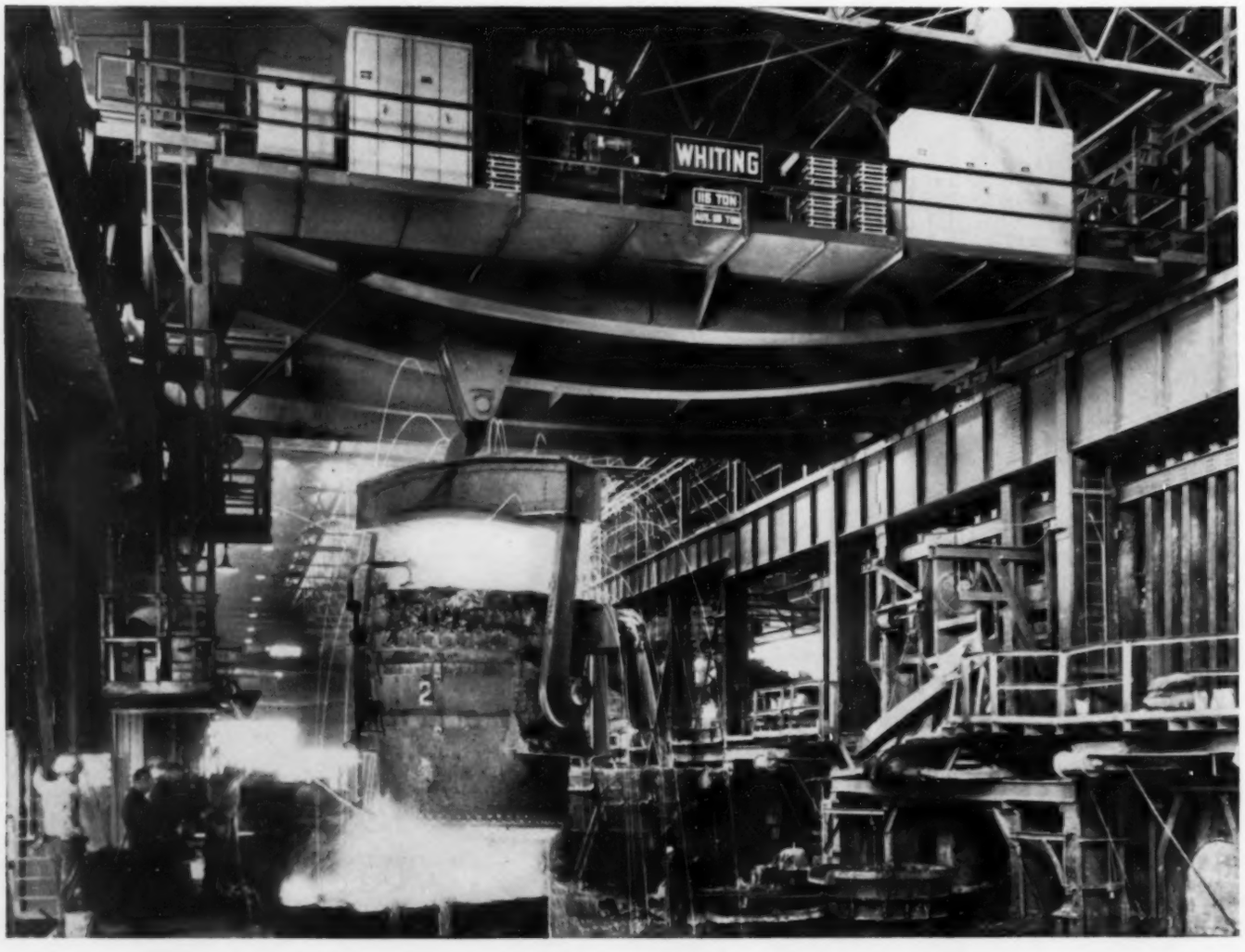
In designing the complete electrical system of your crane, G-E engineers work closely with your crane manufacturer to assure completely co-ordinated equipment. This integration of all mechanical and electrical components assures you of top crane operation, minimum downtime, and lower over-all operating costs. And because G.E. has a complete line of crane controls you are certain to get performance tailored to your specific operation.

ACCURATE HOIST CONTROL for every speed and load is assured with G-E d-c drives. Operational features, such as, five distinct speed points, dynamic braking, automatic acceleration and deceleration, and non-cycling operation provide you with a fast, efficient system.

PRECISION BRIDGE AND TROLLEY CONTROLS offer automatic acceleration, smooth reversal of motion without motor overload, and built-in automatic protection against motor overloading.

MINIMUM REPLACEMENT is required with General Electric d-c crane control. Each control component is tested under severe operating conditions and proved for the job before delivery.

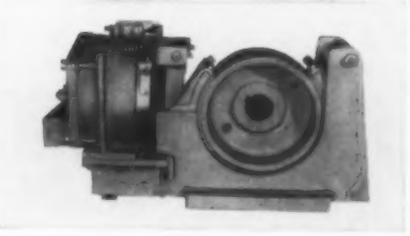
TAKE ADVANTAGE of these benefits by specifying G-E control for your next crane. Your G-E sales engineer will be happy to work with you and your crane manufacturer to engineer the right drive system. Industry Control Dept., General Electric Co., Roanoke, Va.



News for the steel industry

These G-E control products have top features for steel mill use:

DC BRAKES



SINGLE POINT ADJUSTMENT—only one adjustment is needed to regulate lining wear on both brake shoes.

REMOVABLE LININGS—linings can be replaced in minutes, without removing the entire shoe assembly.

ARMATURE GAP INDICATOR—easily visible indicator shows when to adjust for lining wear.

MANUAL RELEASE—a simple and convenient method is provided for manually releasing the brake.

DRUM SWITCHES

DOUBLED CONTACT LIFE—each contact is reversible and may be turned to receive wear on each side, thereby reducing replacement costs.

FAST EASY INSTALLATION—conduit boxes have knockouts in bottom, sides, and back to simplify installation.

REDUCED MAINTENANCE TIME—easily removable covers allow complete access to all working parts.

INTERCHANGEABLE MECHANISMS—standard horizontal handle may be replaced by rope wheel, vertical handle, or switchboard mechanism.

LIMIT SWITCHES

HEAVY DUTY CONSTRUCTION—able to stand up under punishment of severe shock, vibration, moisture, and dust conditions.

REDUCED MAINTENANCE—there are no shunts or drum-type segments to replace or maintain.

LONG LIFE—each double-break, silver contact is independently adjustable for opening and closing.

SIMPLE TO CONNECT AND ADJUST—cover is easily removed to allow access to terminals plus ample wiring space for conduit connection.

MASTER SWITCHES

RUGGED CONSTRUCTION—cast-aluminum cover protects cams and contacts from dirt and dust and accidental rough handling.

FLEXIBLE—may be used with reversing or non-reversing controllers and is available with up to 12 circuits.

EASILY REMOVABLE CONTACTS—the stationary and movable contacts may be removed easily without disturbing the wiring.

POSITIVE MAKE OR BREAK—design of contact mechanism assures positive make or break.

For more information on any of these control products write Section 784-4, General Electric Co., 1 River Rd., Schenectady 5, N. Y.

GENERAL ELECTRIC

Progress Report On Blast Furnace Gas Cleaning

Since the development work was completed five years ago, seven Pease-Anthony Blast Furnace Gas Washers have been installed and are operating. Three more are under construction and many more are in the planning stage.

The following table summarizes the performance of the operating washers:

Installation	Years Operated	Volume SCF	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3–19.0	.01–.04
B	3½	78,000	30	2–3	.02–.08
C	3	85,000	30–40	2–3	.01–.03
D	3	45,000	30	2	.02–.03
E	½	75,000	50	–	.02
F	½	26,000*	12	5	.10
G	½	26,000*	12	5	.10

Installation C is in Illinois. All others are in Pennsylvania.

*Two units in parallel on one furnace. Higher clean gas loadings due to lower available top pressure.

Users enthusiastically approve these modern washers. Typical comments from Chief Engineers, Blast Furnace Superintendents and Combustion Engineers are:

"The P-A Washer requires zero maintenance."
"No secondary cleaner required."
"Gives consistently good cleaning at all times."
"A *natural* where high top pressures are used."

For further information contact

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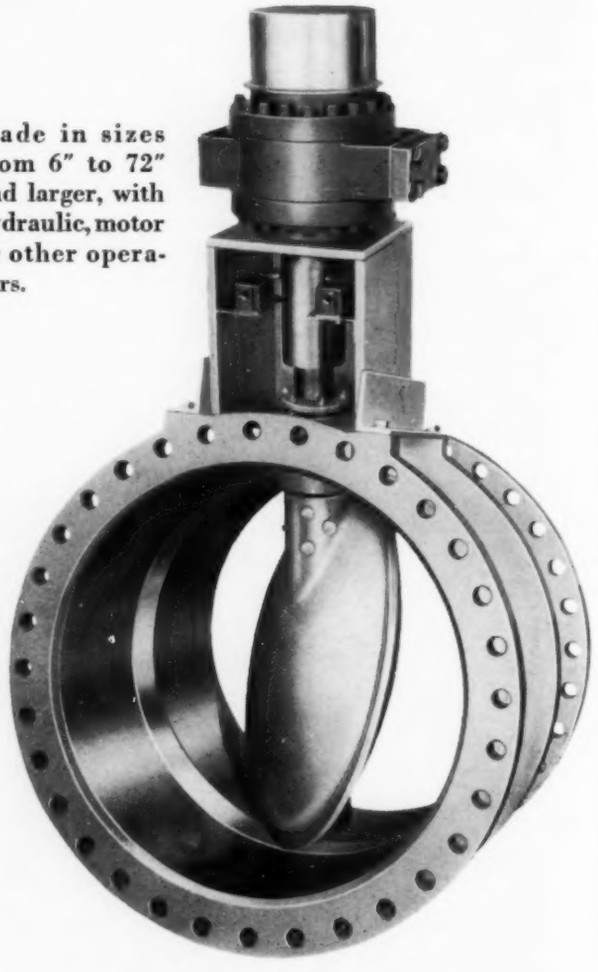

W. S. Rockwell valves are made in many types and materials of construction for handling air and gases, from sub-zero to 1600° F., cooling water, process fluids and granular solids. These are available in butterfly, slide, gate, swing gate, check and other types. Write for catalog.

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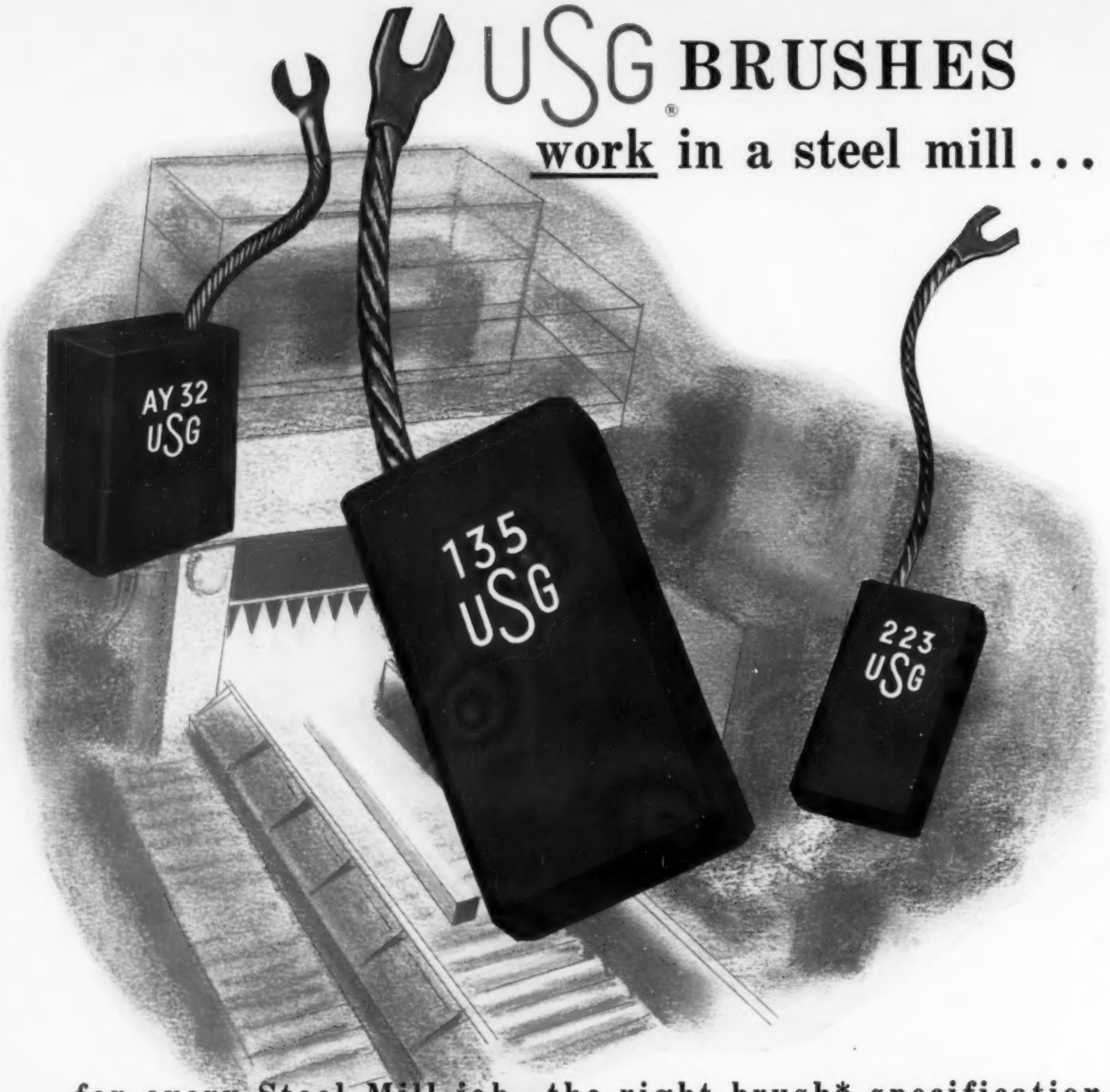

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(1) Welding Steel Castings

"Recommended Practice for the Welding of Steel Castings" is the title of a 40-page manual published by the Steel Founders Society of America. The manual is divided into three sections. The first section covers welding methods. The second section is devoted to electrodes. The third section is a comprehensive discussion of recommended welding procedures for carbon-steel and low-alloy steel castings.

(2) Magnetic Brake

Westinghouse Electric Corp., has published a booklet on their new d-c magnetic brake. This brochure pictures brake features such as a totally-enclosed dust-tight magnet housing, a conduit box, emergency handle release, and lifting eyebolts. Schematic diagrams describe how the self-adjusting brake works.

(3) Cupola Refractories

"Carbon Products for Cupola Furnaces" is the title of a catalog available from National Carbon Co., a Division of Union Carbide and Carbon Corp. Opening with a list of the unusual chemical and physical properties that make amorphous carbon an excellent neutral refractory for cupolas, the bulletin then describes in detail carbon's various cupola applications. Descriptions of well zone linings, breast and tap hole constructions, slag dams, and slag and iron trough linings relate the properties of carbon to these specific refractory problems. A supplemental catalog section on the installation and maintenance of front slagging spouts gives complete procedural details. (S-5450)

(4) Mechanical Drive Turbines

Described in a new publication available from General Electric Co., are their high speed mechanical drive turbines. Construction and design features of turbine drives for centrifugal compressors and blowers are covered in detail in the new bulletin. Cross sections, schematic drawings, cutaways, and typical installation photos point out design features and applications for single-valve, single and multi-stage turbines, as well as multi-valve multi-stage and multi-valve single-stage units for high back pressure applications. Some of the features described include all welded seamless oil piping with flanged connections, solid rotor construction, multiple dovetail buckets, large pressure pad bearings, labyrinth and carbon packing to assure more effective steam seal. Operation and arrangement of the governing system for close speed control is also discussed in detail. Steam rate tables and curves are included for calculating approximate rates for condensing and non-condensing multi-stage mechanical drive turbines. A handy table at the end of the bulletin lists eight factors to be determined when ordering a mechanical drive turbine. (GEA-6232)

(5) Coil Equipment

Available from the Herr Equipment Corp., is a bulletin describing and illustrating their line of processing and handling equipment, including coil cars, pay-off reels, levelers, slitters, shears and coiling reels. In addition, the brochure covers stitchers, press feeds, bridles, tube mills and expanders. (Bulletin 561)

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52	BABCOCK AND WILCOX CO., THE	BULLETIN R-35	Refractory castables.
53	BAILEY METER CO	SPEC. E65-1 AND E12-5	Recorders.
54	BLAW-KNOX CO., FOUNDRY AND MILL MACHINERY DIV.		Continuous mechanical chipping.
55	BLISS CO., E. W	CATALOG 40-A	Rolling mills.
56	BROOKS OIL CO		Lubricants.
57	BUFFALO FORGE CO	BULLETIN 2424-F	Rubber-lined exhausters.
58	CHEMICAL CONSTRUCTION CORP.		Venturi scrubbers.
59	CLEVELAND WORM AND GEAR CO	CATALOG 400	Worm gearing.
60	CUNNINGHAM CO., M. E	DATA SHEET 653	Billet mill cut letter stamps.
61	CUTLER-HAMMER, INC		D-C Brake.
62	DE LAVAL STEAM TURBINE CO	BULLETIN 0504	Centrifugal blowers and pumps.
63	DIAMOND POWER SPECIALTY CORP		Industrial wired television.
64	DRAVO CORP	BULLETIN 225	Bridges, floating cranes, trolleys and other equipment.
65	EATON MANUFACTURING CO	BULLETIN FAS-5	Adjustable speed drives.
66	ELECTRIC CONTROLLER AND MFG. CO., DIVISION OF SQUARE D CO	BULLETIN 1004	Brakes.
67	ELECTRIC CONTROLLER AND MFG. CO., DIVISION OF SQUARE D CO	BULLETIN 942	Tab-weld plate resistors.
68	ELECTRIC CONTROLLER AND MFG. CO., DIVISION OF SQUARE D CO	BULLETIN 921-930	Magnetic controls.
69	EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO		Ironclad batteries for electric industrial truck operation.
70	FARREL-BIRMINGHAM CO., INC.	BULLETIN 273	Rolling mills.
71	FOXBORO	AED SHEET 330-1 AND BULLETIN 11-11	Automatic control of blast dew point.
72	FRANTZ CO., INC., S. G.	BULLETIN PM-44	Magnetic separators.
73	GARLOCK PACKING CO., THE	CATALOG NO. 10	Oil seals.
74	GEAR GRINDING MACHINE CO., THE		Constant velocity universal joints.
75	HAGAN CORP	SPEC. FILE TP-MFI	Power positioners.
76	HOMESTEAD VALVE MFG. CO	REFERENCE BOOK NO. 39-3	Lever-sealed plug valves.
77	INDUSTRIAL GEAR MFG. CO		Industrial cut gear products.
78	KAY LAB		Industrial television.
79	KOPPERS CO., INC., FAST'S COUPLING DEPT		Couplings.
80	LECTROMELT FURNACE CO., DIVISION McGRAW ELECTRIC CO	CATALOG NO. 9-B	Furnaces for metal melting and refining work.
81	LOEWY-HYDROPRESS DIVISION, BALDWIN-LIMA-HAMILTON CORP.	BULLETIN L-144	Planning stages to full scale production services.
82	MARKAL CO		Marking problems.
83	MASTER BUILDERS CO., THE		Grouting guide.
84	NATIONAL CARBON CO., DIVISION UNION CARBIDE AND CARBON CORP.	CATALOG SECTION B-0635	Mill-motor brushes.
85	OKONITE CO	BULLETIN EW-1100	Non-destructive testing of cable.
86	PANGBORN CORP	BULLETIN NO. 224	Descaling machines.
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89	ROCKWELL CO., W. S		Valves.
90	RUST FURNACE CO		Furnaces.
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96	WAGNER ELECTRIC CORP	BULLETIN TU-57	Transformers.
97	WESTERN PRECIPITATION CORP		Cottrell electrical precipitators.
98	WHEELABRATOR CORP		Airless blast cleaning machines.
99	WILSON-SNYDER WORKS, UNITED STATES STEEL CORP		Pumps.
100	WW ALLOYS, INC		Aluminum bronzes.
101	YODER CO. THE		Slitter operation.

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IRON & STEEL ENGINEER

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PITTSBURGH 22, PA.

Vol. 3 No. 2

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS

FLEXIBILITY OF THE MODERN ELECTRIC FURNACE STEEL PLANT

Charging — the electric furnace takes all forms of scrap . . . starts up and shuts down at a moment's notice . . . has low initial and operating costs that yield quickest return on investment dollar.

FLEXIBILITY—
99 hours from order to finished product

ON the basis of flexibility alone, the electric arc furnace is a contender for the title of number one tool of modern steelmaking. No other method of steel production offers such a wide variety of advantages:

- Ease and speed of start-up and shut-down — adapts instantly to market conditions.
- Maximum latitude in slagging practice — widest variety of product.
- Less space per ton of capacity — lower plant investment.
- Maximum equipment availability — wider distribution of fixed costs.
- Low initial cost, low operating and labor costs — quickest yield on investment dollar.
- Adapts to custom or production runs — handles large and small orders with equal facility.
- Utilization of all types of scrap — lower cost of metallics.
- Top quality of product from stainless grades to carbon steels — improves competitive position.

Growth of electric furnace output during the last ten years — 80% of which is in the field of carbon steel production — points to the many advantages the arc furnace process offers all steelmakers, both in integrated and non-integrated plants.

A typical speciality mill such as Rotary Electric Steel Company in Detroit, Michigan, is actually a closely knit unit, each of whose appendages is highly sensitive to the requirements of its function within the whole. The efficiencies of a manufacturing assembly line are present, but obscured to the inexperienced eye by the magnitude and scope of the operation.

What seems a ponderous, even a leisurely undertaking is really a network of split-second coordinations. It must be so. In the electric furnace steel industry, where the wage bill is a smaller percentage of operating cost than in most industries, lost product — even more than lost man-hours — means big money. No effort is spared to make every melt as perfect as technology and experience can insure.

How can the relatively few electric furnace steel-mills in this country turn out the huge tonnages of finished and semi-finished product that are needed to supply thousands of processors, finishers, fabricators, assembly shops and parts and products manufacturers?

Melting — short melt cycles — from 5 to 7 hours — make the electric furnace equal, in output, to an open hearth of several times its nominal capacity. Electrics occupy less space, provide maximum equipment availability . . . wider distribution of fixed costs.

The answer lies in their *flexibility*. Flexibility, not only to operate at a constantly changing percentage of capacity to suit changing market conditions; but the ability, as well, to make that operation serve the most widely divergent and changing requirements of individual customers.

Let's say you're manager of a jobbing machine shop in the Detroit area, turning out specialities from stainless, alloy and carbon bar stock. Suddenly, you're up to your belt buckle in orders and nearing the end of your raw materials inventory which is

Tapping — electrics assure top quality product from stainless grades to carbon steel . . . improve competitive position through greater adaptability to market conditions . . . offer maximum latitude in slagging practice . . . widest range of product.

Teeming — cautiously the high quality, electric furnace steel is poured from ladle to ingot mold. Ceramic hot tops insure a sound ingot with minimum crop loss.

never very large. You can't wait for the mails and for ordinary processing of your inquiry. You are faced with the costly prospect of idle men and machines.

You call Rotary Electric. The TIME is 10:00 AM. In a matter of minutes, your order is analyzed by the Order Service Department. First, inventory is checked — nothing available in billet form for your job.

Next, the current melt schedule is investigated — there is a heat of suitable analysis due to be poured the following day with sufficient overage to make a part shipment on your 20-thousand pound order. Now we're getting somewhere! The TIME is 10:07 AM.

The order is written in a specially developed business machine order section which types and codes all pertinent information

Soaking Pit — Slowly the ingot rises from its bath of fire, properly heat-conditioned for the next operation.

available at this time, from date of order to the data needed for automatic invoice preparation. This formerly time-consuming paper work now requires just nine minutes. The TIME is only 10:16 AM.

From here on, the order travels with the steel. The Metallurgical Department processes it, entering instructions from previous orders, including the chemistry of the steel, sequence of operations, special finishes, packaging and shipping instructions. The TIME is 10:20 AM. Simultaneously, the Production Department makes a note to remove this quantity of steel from inventory and the Scheduling Department arranges for rolling the steel which is coming through early the following morning.

After careful appraisal of other mill commitments, every possible readjustment of the schedule is made to accommodate this emergency order. The ingot is poured at 12:05 Midnight. By 8:10 AM of the second

Blooming Mill — the ingot is rolled into a billet . . .

day, it has left the soaking pit. Quickly it passes through the blooming mill, is pickled, conditioned, reheated and rolled into a bar by 8:00 that evening.

Annealed and ready for cold finishing 32 hours later, the order is inspected and shipped at 1:00 PM of the fourth day — exactly 99 hours from time of the telephone call and starting from scratch. The remainder of the order will be shipped two weeks from date of receipt.

That's how the flexibility of the electric furnace steel mill works for its customers to contribute its giant share to the prosperity and comfort of the consuming public.

. . . which becomes a smaller and smaller square and, finally, in the bar mill, a finished round.

Annealing — Here normalizing temperatures ease the stresses set up by mill-work . . . prepare the finished bar for ultimate machining, forming, forging or welding operations. Once again, flexibility of the electric furnace steel shop proves its ability to deliver the goods — *fast!*

All photographs courtesy of Rotary Electric Steel Company, Detroit, Mich.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
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UCC

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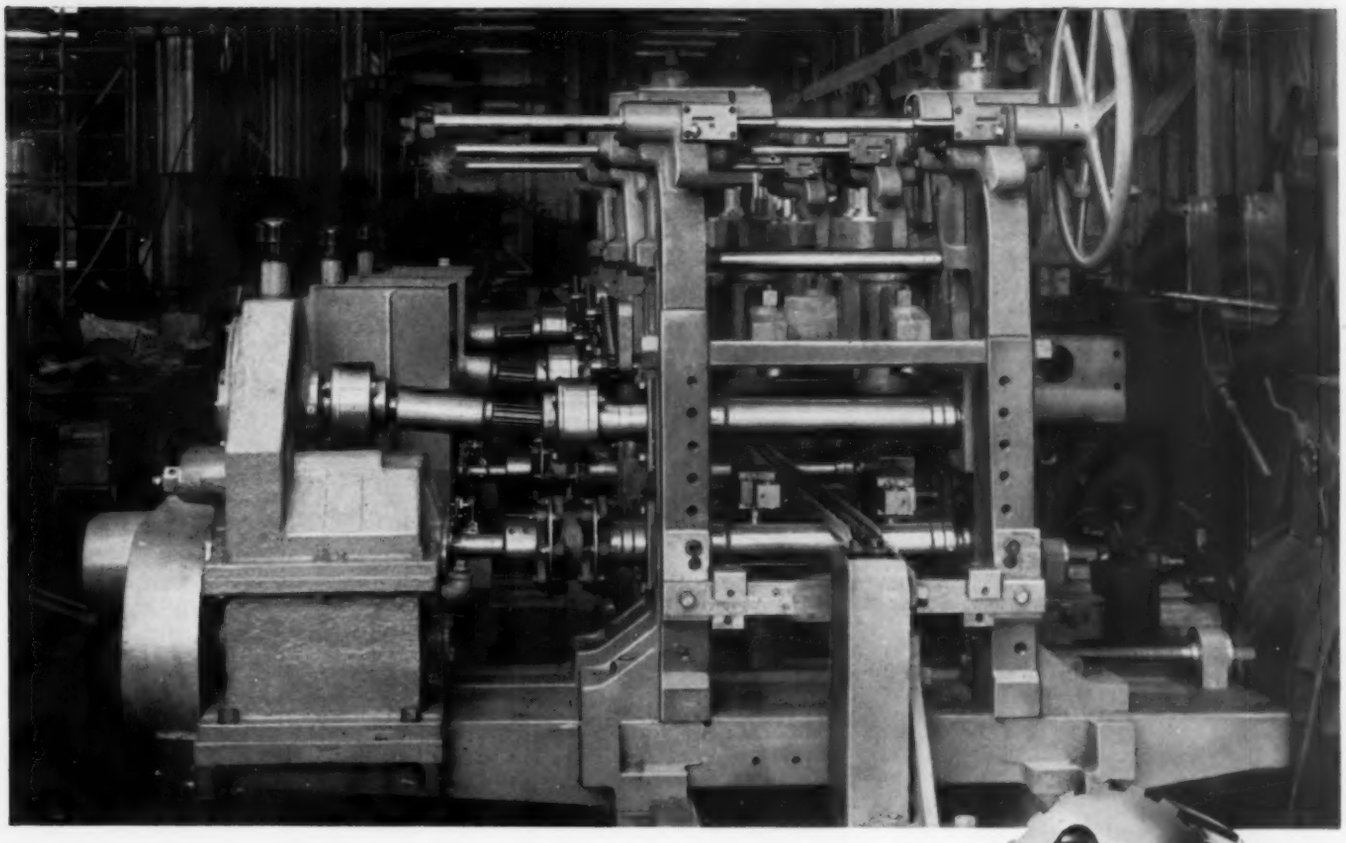
How RZEPPA constant velocity universal joints help provide scratch-free aluminum extrusions



PROBLEM:

This equipment—built by the Sutton Engineering Company, Pittsburgh—is the answer to a problem common to processors of extrusions: how to correct cross-sectional distortions that occur in the extrusion and heat treatment of today's complex shapes.

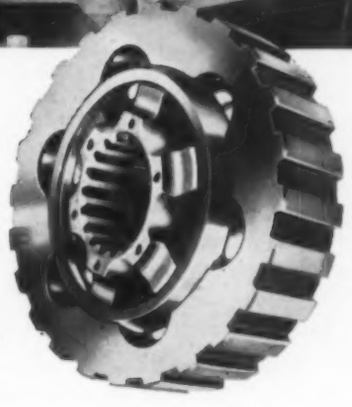
SOLUTION:

Sutton solved this problem with their new concept of giving accurately-proportioned torque to the top and bottom rolls through differential gearing.

Rzeppa Constant Velocity Universal Joints were added to overcome scratching and gouging caused by the irregular action of ordinary universal joints. Rzeppa Joints are giving scratch-free finishes even at extreme operating positions.

Other *modern design* advantages offered by Rzeppa include:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- HIGHER CAPACITIES



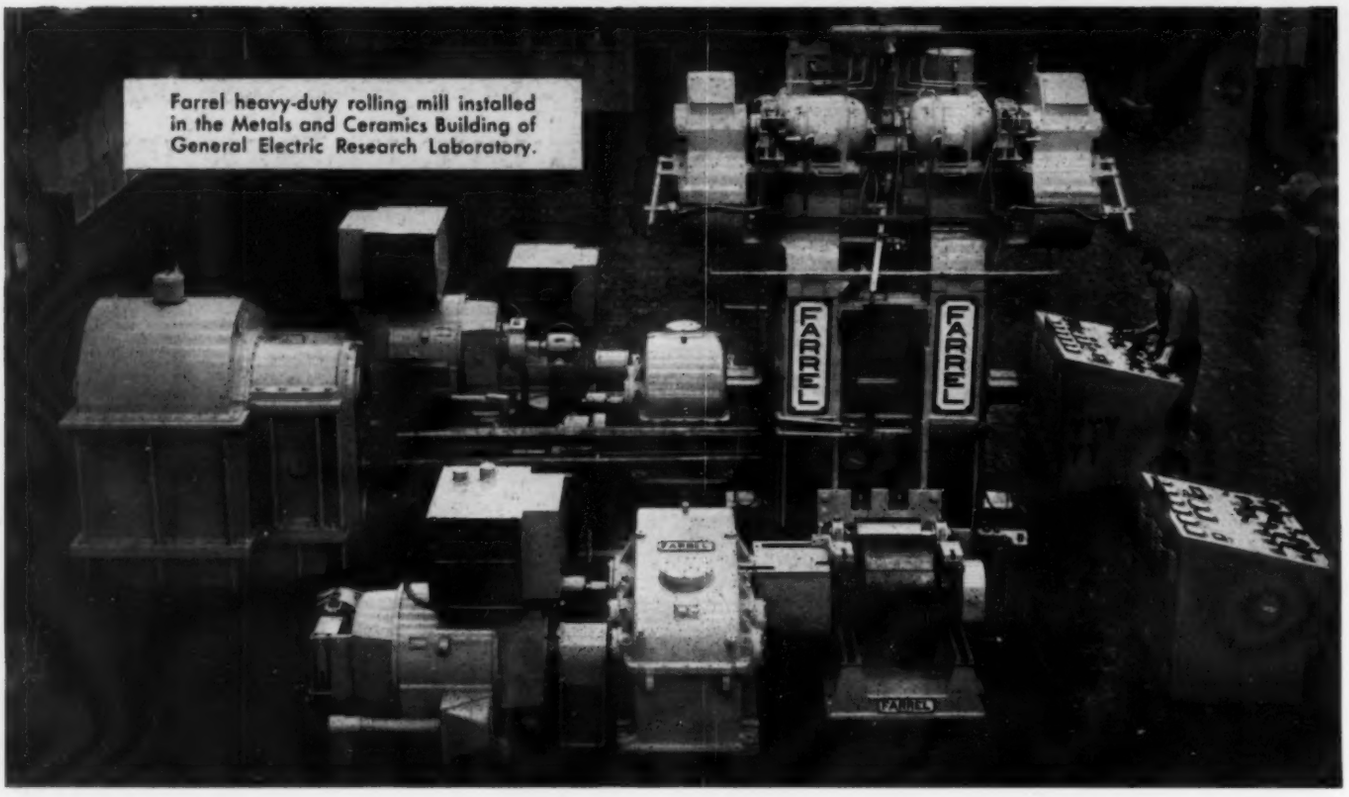
If you would like to know more about the outstanding capabilities of Rzeppa Constant Velocity Universal Joints, write today for your free copy of this complete, informative brochure.

RZEPPA SHEPPA CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY

3929 CHRISTOPHER, DETROIT 11, MICHIGAN

MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES • THE DETROIT SCREWMATIC 750



Farrel heavy-duty rolling mill installed in the Metals and Ceramics Building of General Electric Research Laboratory.

This hot or cold reversing mill was designed for rolling super alloys

The Farrel® mill illustrated above was specially designed for rolling a variety of the super alloys currently in demand, as well as even tougher metals which may be developed.

On trial runs it has given a good account of itself, with close gauge control. Factored for extreme rigidity and strength, the mill has a number of features which give it unusual versatility. A few of these are described at the right.

A Farrel mill can be built to meet your specific needs. Just tell us your requirements, and one of our engineers will be glad to discuss your problem with you.

In the meantime, send for a copy of bulletin 273. This 36-page book illustrates the broad line of Farrel rolling mills.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Chicago,
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Farrel-Birmingham®

FARREL METAL WORKING MACHINERY: Rolls • Rolling Mills • Slab, Rod and Strip Handling Equipment • Roller Tables • Rod Coilers • Slitters • Gears • Gear Drives of Any Capacity • Mill Pinions • Pinion Stands • Universal Mill Spindles • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Hydraulic Presses for Extruding, Forming, Drawing, Forging, Trimming, Hobbing, Straightening and Bending.

MILL FEATURES

Designed to operate as a 2-, 3- or 4-high reversing mill, for either hot or cold rolling, the entire unit is controlled from either of two pulpits. Power is supplied through a Farrel combination drive and pinion stand. Two direct-current motors, electrically synchronized, drive the rolls. Speed adjustment is by stepless speed variators; no matching of roll diameters is required.

For operation as a 4-high mill, a pair of 3" or 6" diameter by 16" face work rolls are used; backup rolls are 21" diameter. For 2-high operation, rolls up to 24" diameter can be accommodated. For 3-high operation, either a 3" or 6" work roll can be used. In the 4-high arrangement, provision is made for driving either the work rolls or backup rolls.

The mill has high-speed screwdown to facilitate roll changing and for roughing; and slow-speed screwdown for fine adjustment when finish rolling.

For roll changing, a porter bar is supplied for the work rolls, and an integral roll sled for the backup rolls. Tension winders provide 20,000 lbs. tension.

NOW
BILLET MILL OPERATORS
IDENTIFY
POSITIVELY!

Border design identifies positively, even with partial impression. "T" in triangle is used for top, "M" in cloverleaf for middle, "B" in circle for bottom. Available in three styles—standard single and double end, and 4-section stamp.

Mecco SAFETY
BILLET MILL
CUT LETTER
STAMPS

Write for Data Sheet 653.

Mecco SAFETY MARKING TOOLS
M.E.CUNNINGHAM CO.
1041 CHATEAU STREET, PITTSBURGH 33, PA.

EMBECO PRE-MIXED GROUT
is *Ready to Use*

NON-SHRINK GROUTING of
Heavy Equipment • Machinery
Anchor Bolts • Building Columns • Etc.

Write For Free Grouting Guide

DIVISION OF AMERICAN-MARIETTA COMPANY
the MASTER BUILDERS co.
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HYDRAULIC EQUIPMENT WORKS BETTER with
FERROFILTER

FERROFILTER
Model PQ-6 with flanged inlet and outlet for 3" pipe line.

MAGNETIC SEPARATORS on the Job

Frantz FERROFILTERS protect fluid power systems by removing fine ferrous particles which may pass freely through edge-type strainers and even escape conventional cartridge-type filters. These magnetic separators help prevent the sticking and wear of valves, cylinders, pistons and pumps.

Send for BULLETIN PM-44

S. G. FRANTZ CO., Inc.
Brunswick Pike and Kline Ave.
P. O. Box 1138 Trenton 6, N. J.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

NOW—ALLOY CHAIN REPAIR SERVICE

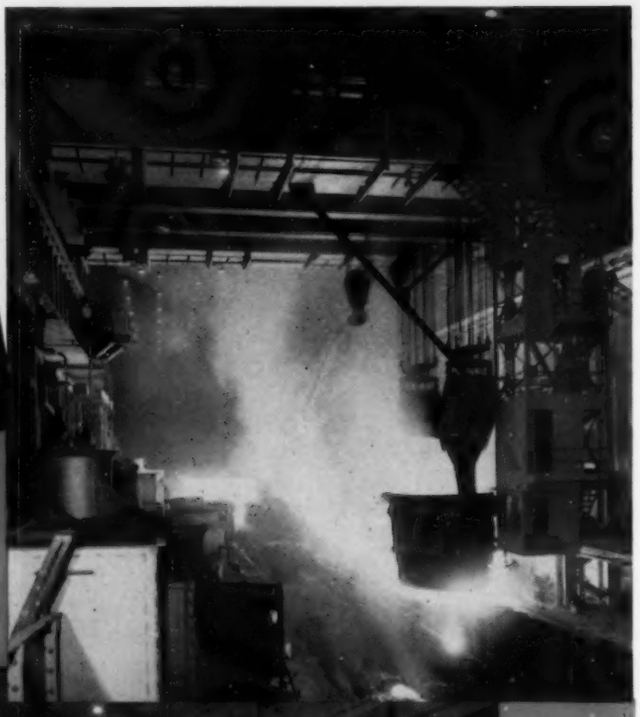
in PITTSBURGH and HAMMOND
For greater safety and economy, have your Alloy Sling Chains returned to either our Pittsburgh or Hammond plant for repair, inspection and testing, at nominal cost.

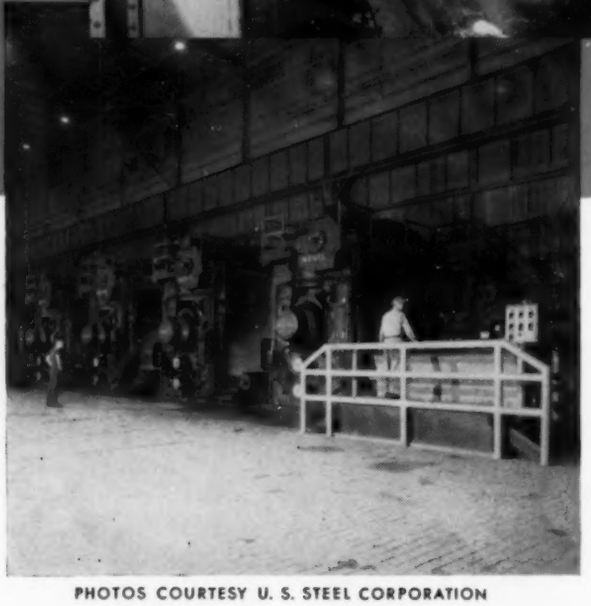
S. G. TAYLOR CHAIN CO., Hammond, Ind.
and 3505 Smallman St., Pittsburgh 1, Pa.

OVER 20,000 BEARINGS ARE LUBRICATED AT FAIRLESS WORKS BY

Trabon

LUBRICATION SYSTEMS





PHOTOS COURTESY U. S. STEEL CORPORATION

The following wide range of equipment at U. S. Steel's new Fairless Works is lubricated around the clock by TRABON *positive* centralized lubricating systems: Wellman Ore Bridge; E. W. Bliss Hi Scale Breakers; Arthur G. McKee Blast Furnaces; Atlas Ore Transfer Cars; Wean Combination Line; Alliance Cranes; Cleveland Cranes; American Bridge Cranes; Wellman Charging Machines; Dravo Ore Unloaders; E. W. Bliss 80″ Pickle Line; Mesta 45″ Slabbing Mill; Mesta 80″ Hot Strip Mill; Morgan 10″ Merchant Mill; Continental 40″ Blooming Mill; United Billet Mills; Morgan Scale Yard Crane; E. W. Bliss Cold Mills.

This installation of TRABON systems, automatic and manual, assures each bearing point accurate lubrication as frequently as it is required.

Write for our detailed literature for further information on TRABON versatile, trouble-free lubricating systems.

Trabon ENGINEERING CORPORATION

1814 E. 40th STREET • CLEVELAND 3, OHIO

Oil and Grease Systems

Equipment News...

VOLTAGE RECORDER

▲ Variations in roll speeds for steel mills can now be recorded and indicated precisely with a differential voltage recorder manufactured by General Electric Co.

Two instruments are available for increased application versatility. One recorder has a scale and chart for direct reading of feet-per-minute draw —the "stretch" of the steel. The other recorder measures and indicates ratio between roll speeds.

A d-c tachometer is geared to each of two rolls. Voltage difference of the two tachometers expresses any difference in roll speed. Simple adjustment of either tachometer circuit allows for difference in gearing and roll size. The recorders are unaffected by changes in operating speeds, recording only draw and ratio during speed-ups or slow-downs.

Use of plug-in amplifiers helps reduce down time and simplify maintenance of the recorder.

Semi-flush mounting dimensions for the differential voltage recorder are: 17⅞ in. high, 15 3/16 in. wide, and 12 5/32 in. deep behind the panel.

INDUSTRIAL FILTERS

▲ The R. P. Adams Co., Inc. has introduced a new filter line in the IWF industrial filter.

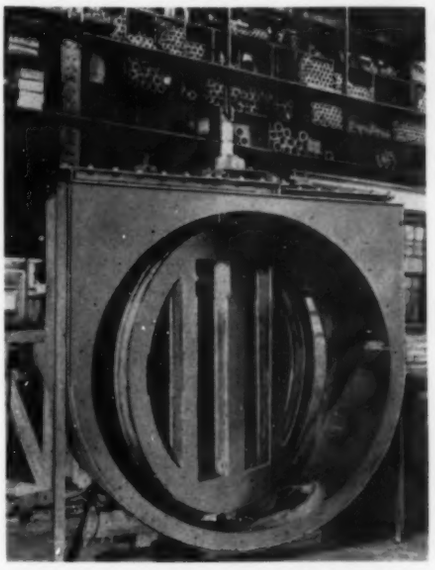
Features of the IWF include: the efficient high flow backwash design which eliminates disassembly for cleaning; a choice of five basic sizes in numerous arrangements of multiple units in each size; four different filter elements, Poro-Stone, Poro-Carbon, Poro-Screen and Poro-Edge, to provide a suitable septum for most process needs; high-polish, diatomite filtration with or without continuous body feed; batch or fully continuous "on-stream" operation; and standard ASME construction.

The high flow backwash design of the Adams WFF Filter is retained in the new IWF unit. In this design, a compressed air head is developed in the high dome of the filter shell. The compressed air acts as a dynamic force which drives the backwash liquid in a reverse direction through the filter elements when the backwash valve is open.

High initial backwash flow rates are obtained because the compressed air is acting on the entire surface area of the backwash liquid. These high reverse flow rates are sustained for a longer period of time due to the stored energy available from compressed air.

This sustained, high-flow reversal of the backwash liquid purges the filter element pores of all foreign matter.

BUTTERFLY VALVE



This butterfly valve built by Blaw-Knox Co. for a cupola will be installed in a brick lined steel duct with a 7-ft inside diameter. Because it is cellularly constructed, the damper requires less plant cooling water for protection against superheated gases. The customer will line the casing and fill the openings between the water passages with brick or other refractory material.

CONTINUOUS MIXERS

▲ Available from the Gas Machinery Co. is a new line of continuous mixers and pug mills.

These mixers will handle any size material from dust to 1½ in., either dry or in a slurry. Although manufactured in standard sizes, they can be supplied with product capacities to fit particular needs.

The mixers feature all welded frame of heavy steel plate; standard replaceable mixer trough of heavy gage material; box-type construction that eliminates dirt catching framework; safety guard over mixing portion of trough; simplified highest quality drive mechanism with standard NEMA frame motor for easy emergency replacement; diversion plate at mixer discharge for elimination of segregation tendencies; and expansion-type roller bearings used for shaft support.

The drive mechanism may be located on either side of the trough or in line with the trough axis.

CRANE INTERCOM

▲ Mine Safety Appliances Co. has introduced a new FM carrier communications system at the Sheffield Steel Division of Armco Steel Corp. in Kansas City, Mo. This installation has made possible clear oral communications without interference or risk of misunderstandings.

Three stations in crane cabs with a base station, a remote station in the soaking pit area, and a base station and a crane cab station in the blooming mill make up the initial installation.

Each mobile or crane station con-

Adustable equipment permits crane cab operator to talk directly into microphone. His hands are free to handle controls.

WW Aluminum Bronze—what it is and what it can do for you

Aluminum bronzes comprise a group of copper base alloys containing up to 15% aluminum. Generally, each of these alloys also contains a lesser amount of one or more other elements such as iron, nickel, manganese or silicon.

By changes of the chemical composition, by variations in the alloying techniques, by special heat treatment, or by combinations of these methods, the properties are controlled, and can be made to range from those of moderately strong alloys with excellent ductility, to those of extreme hardness and high compressive strength for applications where ductility is not a requisite.

Structurally, there are two types of aluminum bronzes—single phase alloys and two phase or duplex alloys. Duplex alloys contain more than 8.5% aluminum. The single phase alloys are readily cold or hot worked and are strengthened only by cold- or hot-working. The duplex aluminum bronzes can be cold-worked to a limited extent, but can be readily hot-worked, hardened and tempered.

What it can do for you

All of the WW Aluminum Bronze alloys are characterized by their excellent resistance to wear and low coefficient of friction in contact with dissimilar metals. They have good resistance to corrosion and to scaling at high temperatures. In addition, they are anti-magnetic and non-sparking; they have vibration damping properties and specific gravities lower than those of other copper alloys. In fact, the strength to weight ratio of aluminum bronze is comparable to heat treated aluminum alloys.

These unique characteristics make aluminum bronze important to the product designer in the following typical applications:

Wear Resistance—bearings, bushings, machine tool parts, forming and drawing dies, wear plates, gears, cams, worm wheels, slides, guides, etc.

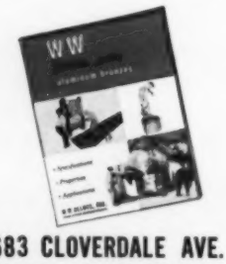
Corrosion Resistance—heat exchanger equipment, cylinder heads, pump parts, pickling equipment, autoclaves, valve sleeves, marine parts, etc.

Non-Magnetic—electrical parts, instrument housings, aircraft and marine parts, etc.

Non-Sparking—tools: hammers, sledges, saws, wrenches, crowbars, picks, shovels, etc.

WW Alloys maintains its own foundry and forging facilities for *premium quality* centrifugal, sand, permanent mold castings to your specifications. Parts can be furnished partly or finish machined, ready for use.

Write now for our 32-page bulletin "WW Aluminum Bronzes," containing a comprehensive description of the alloy group, engineering data and specifications for individual alloys, drawings, tables of machining recommendations.



WW ALLOYS, INC.

11683 CLOVERDALE AVE.
DETROIT 4, MICHIGAN

Division of Fansteel Metallurgical Corporation

sists of a loud speaker, an adjustable microphone, and a foot switch to close the microphone circuit while leaving the operator's hands free at all times.

The base or ground stations are compactly housed units. Each has a microphone-speaker combination with a pull-down-to-talk switch.

At the Sheffield plant, the installations enable men in the pulpit station of the blooming mill to notify the crane operators when to draw an ingot from the soaking pits. Timing is vital. The ingots must be drawn at the proper time so there is no delay in rolling. Allowing the ingot to cool would necessitate reheating operations.

The communication system is free of transmission noise and outside interference and can be heard clearly above the noise of nearby operations. No special wiring is necessary. The FM carrier waves are transmitted over existing electrical circuits.

Any desired frequency within the range of the equipment may be set up, and ten different frequencies are possible within a single plant without cross interference. A range of one mile is possible with satisfactory power line conditions.

The system also may be operated on batteries in instances where no power lines are available such as remote docks or barges.

COLLECTOR-DRAFT UNIT

▲ Breslove Separator Co. has announced a regenerative fly ash collector-induced draft unit which combines a fly ash collector and induced draft fan in a single easily installed unit. The collector section removes fly ash, soot, and cinders from stack gases, and the fan section provides draft for boiler operation.

The collector section is combined with a high efficiency induced draft fan in a single "package" unit.

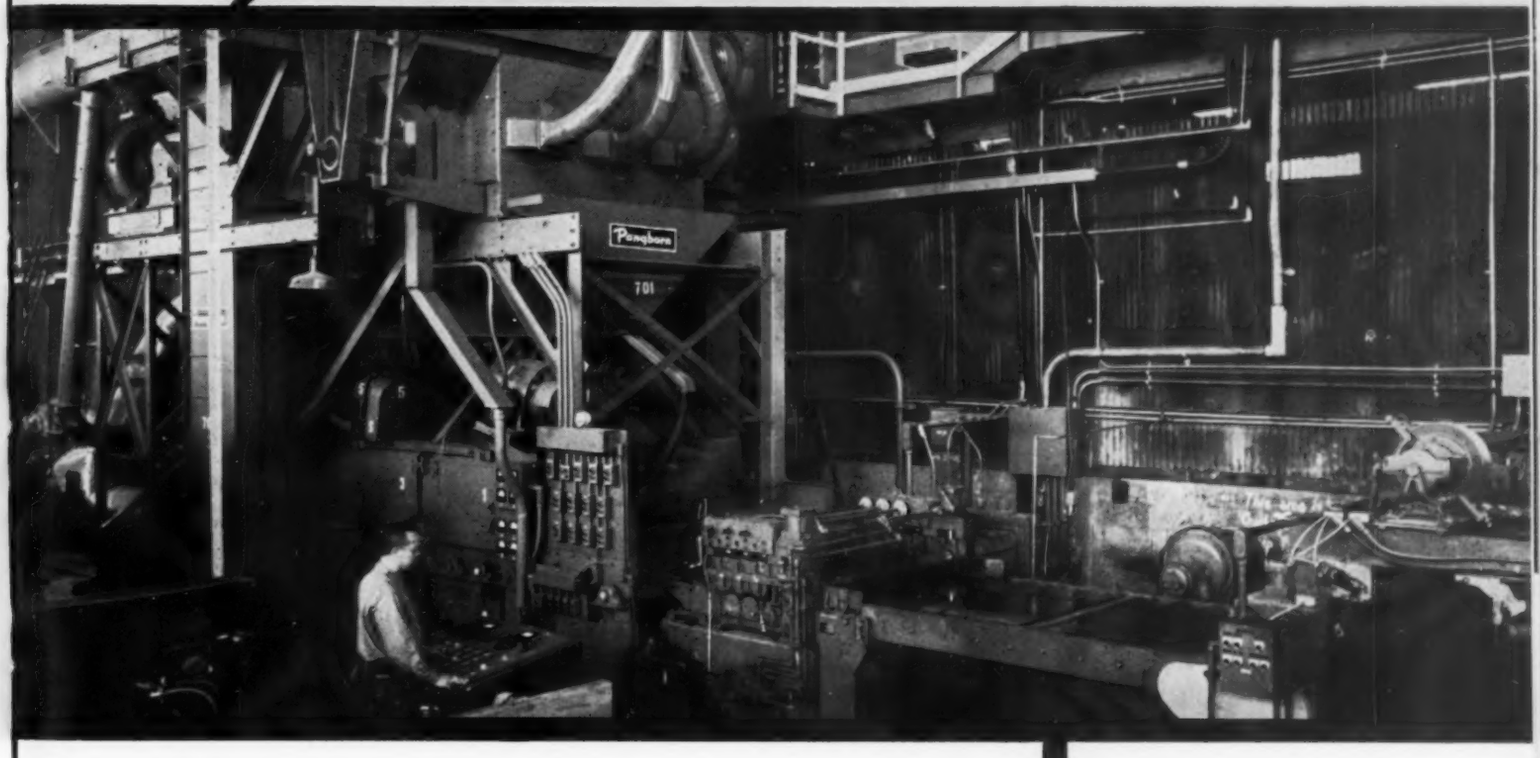
These units can be used for new boilers where they provide all the draft required; or they can be used with existing boilers that require dust collection and increased draft to improve performance or to handle greater loads.

They are available in a full range of capacities in a number of different physical arrangements to fit different space conditions. Their package design makes installation simple and in

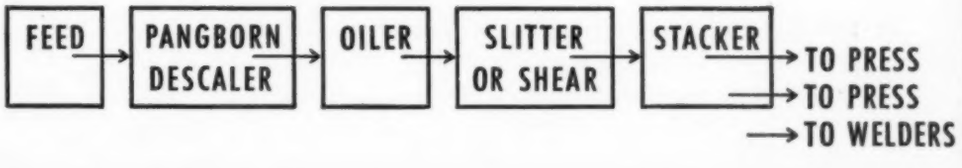
STEEL FABRICATORS!

NOW Pangborn offers you

Automation!



For fabricators using flat steel, coils, cut lengths—Pangborn Rotoblast® Descaling Machines offer *straight line* operation. One feed through descaler, oiler, slitter and stacker!



Here's How You Benefit!

- *You cut costs by using hot rolled unpickled steel.*
- *You speed production.*
- *You reduce labor costs.*
- *You eliminate problem of acid fumes and acid disposal.*
- *You use minimum floor space.*

For full details on automation for fabricators, write for Bulletin Number 224 to Pangborn Corporation, 4400 Pangborn Blvd., Hagerstown, Maryland.

Manufacturers of Blast Cleaning and Dust Control Equipment.

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BLAST CLEANS CHEAPER

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Why Allis-Chalmers Cooling Coil Design Means . . .

Better Rectifier Operation

More Efficient Heat Transfer results from internal cooling coil. The steel coil surrounds active parts, offering more cooling surface and better heat transfer than other types. Unit maintains more uniform temperature and mercury vapor pressure.

Simplified Maintenance results from Allis-Chalmers unique unit construction. All active components are attached to the anode plate for easy withdrawal, dismantling, and re-assembling — as illustrated above.

Positive Arc Barrier is formed by the cooling coil, which is insulated from the tank. The main arc is confined within the coil, preventing arc transfer to the tank.

Years of Operation in hundreds of installations have proved the reliability, ease of operation, and simplified maintenance of Allis-Chalmers mercury arc rectifiers. You can get complete information at your nearby A-C office, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

LIVE BETTER ELECTRICALLY

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A-C ALLIS-CHALMERS

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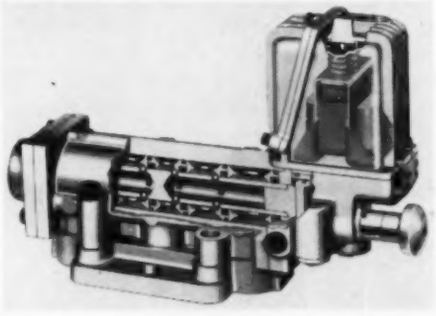
expensive, and their low power consumption keeps operating cost very low.

CONTROL VALVES

▲ C. B. Hunt & Son, Inc., has introduced an entirely new line, known as "B"-Type valves.

Valve chambers are formed by aluminum spacers held in accurate metal to metal end abutment. This patented arrangement greatly simplifies internal construction. It permits the "O" rings or "U" packers to be supported on both the inside and outside diameters without placing any mechanical pressure on the packers.

The hollow, radially ported, stainless steel, ground and polished plunger is the only moving part except the operating mechanism. Flow is from the inlet chamber through the radial ports of the hollow plunger and out



through other ports in the plunger to the connected line. All parts are in pressure balance eliminating any tendency to creep or crawl. The higher the pressure, the tighter the seal.

The sub-base mounting furnished with all "B"-Type valves permits the piping to be connected to the sub-base so the valve can be removed for inspection or repair without disconnecting any of the piping. Dual exhaust in four-way valves permits the speed of the operated piston to be controlled by installing adjustable exhaust plugs in the valve sub-base.

The solenoid operated valves are conservatively rated at 600 cycles per minute for continuous operation on air at pressures from 40 psi to 150 psi; they can be operated at much higher speeds for intermittent duty on air at 80 psi to 100 psi. Exterior feed type valves can be used in hydraulic service at pressures up to 250 psi using air for the pilot medium. Interior feed type valves can be used on oil from 40 to 150 psi at somewhat lower cycling speeds.

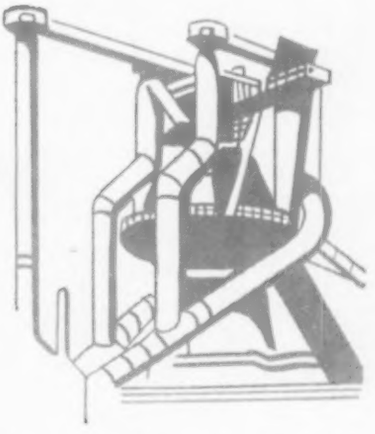
The bottom plate of the solenoid is positioned over steel dowel pins fitted with "O" rings; and is held in place with a spring. The gasketed die-cast water-tight aluminum solenoid cover is split for easy accessibility, finned for cooling and fitted with captive screws and retaining chain.

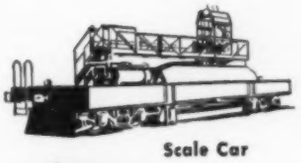
PIPE JOINT COMPOUND

▲ Introduced by Crane Packing Co., is a new chemically inert pipe joint compound that will positively seal practically all known highly corrosive liquids and solvents for services up to 212 F. Known as "John Crane" Chemlon pipe joint compound its base is DuPont Teflon. This material is not only impervious to all types of hard-to-handle fluids, but possesses an extremely low coefficient of friction. The latter substantially reduces wrench torque, permitting connections to be drawn up to a greater degree of tightness without undue stress or strain.

The non-adhesive quality of Teflon and the non-hardening characteristics of the compound allow the connections to be quickly and easily dis-

WHEREVER *performance* COUNTS





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100-ton Ore Transfer Double Compartment, Bottom Dump

Coke Quenching Car

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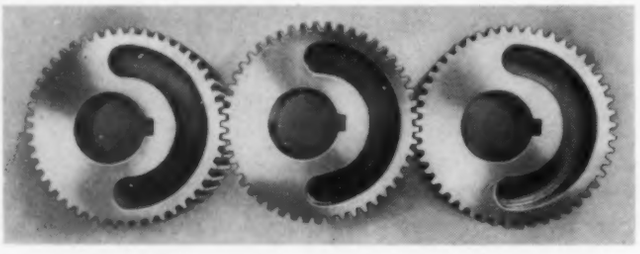
Applying Gearing Effectively in the Steel Industry

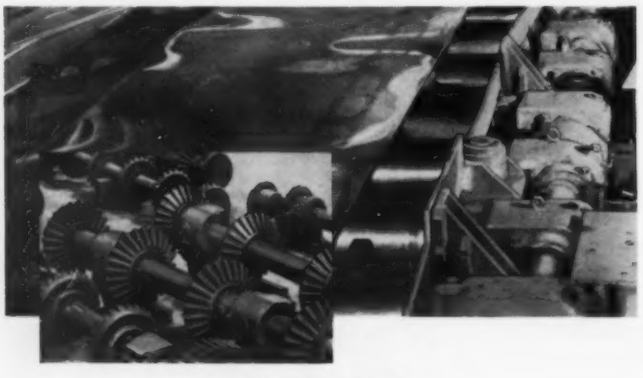
by **Robert Ritzel**
Regional Marketing Manager, Denver
Western Gear Corporation

The requirements for gears and gear drives in the steel industry are both diverse and specialized. Only a company that possesses an intimate knowledge of the industry can provide the most effective answer to these requirements.



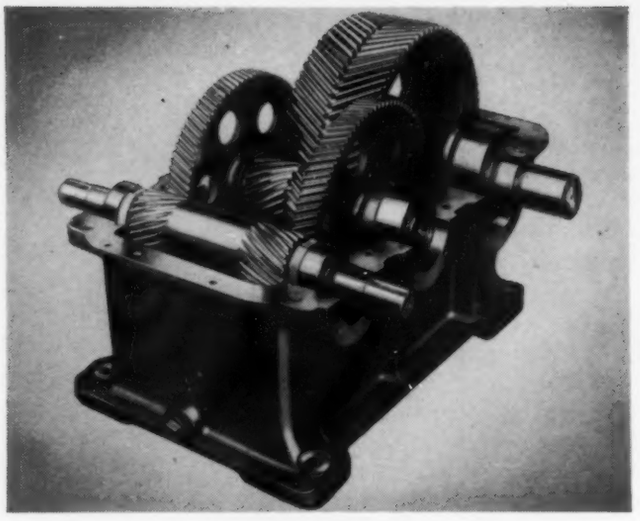
PRECISION ELLIPTICAL GEARS

Western Gear technicians after considerable research have developed a new concept of generating elliptical gears. By generating, the blank and cutter revolve together continuously with the cutter fed across the gear blank as it revolves. Previously elliptical gears were produced by a form cutter with its inherent inaccuracies. Our method insures a proper gear tooth profile, minimizes tooth to tooth spacing tolerances and produces each tooth normal to the true elliptical pitch line. This precision method has resulted in greater life and smoother operation.



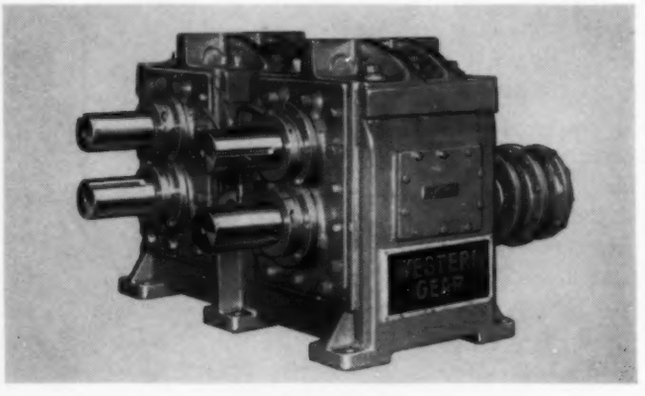
MITER GEARS

Based upon careful and continuous study of the industry Western Gear has gained recognition for many improved applications of gears. The photo shows gearing made for mill table rolls. Today miter gears for mill table rolls are made of carburized alloy steel and also through hardened and later flame hardened .40 to .45 carbon alloy steel. Western Gear maintains its own heat treating department to insure internal control of all heat treating processes.



SPEED REDUCERS

Over the years the steel industry has depended upon Western Gear to supply its speed reducer needs. Western Gear speed reducers are found on main mill drives and auxiliary drives in mills throughout the country. Some of the main applications are on slitter drives, shears, ingot buggy drives; also on cranes, for the hoist, trolleys and bridge drives as well as all types of conveyors. Capacities range from 1 to 10,000 HP. Western Gear speed reducers are of balanced design. Roller-type antifriction bearings carrying only radial loads and all thrust loads are cancelled out due to opposed helix angles, thus giving unrivalled, troublefree service.



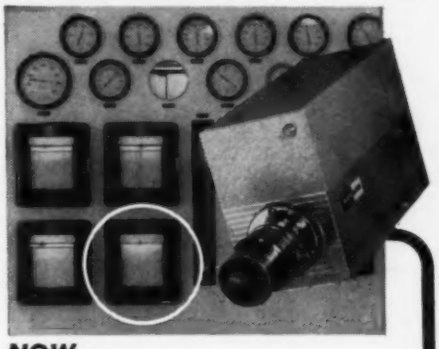
PINION STANDS

Mill pinion stands or combination speed reducer and mill pinion stands built by Western Gear meet the rigid steel industry requirement for custom designed and manufactured equipment. Western Gear has supplied units to steel mills around the world ranging in capacity from 5 to 5,000 HP. Conservative design with compact, rigidly constructed gear cases, precision cut gearing and carefully selected bearings are all a must in the manufacture of a Western Gear mill pinion stand.

Western Gear over the years, with the close cooperation of the steel industry, has accumulated know-how about the many problems that face the steel mill engineer. We invite your inquiries on any power transmission or gear applications that you have and you can be assured that your inquiry will be given the personal attention of one of our key steel mill specialists. Please send your inquiries to Western Gear Corporation, P.O. Box 182, Lynwood, California.

KAY LAB

CLOSED CIRCUIT TV PIONEERS



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VIEW: Production schedules, charts, blueprints, gauges, meters, flames, smokestacks . . .

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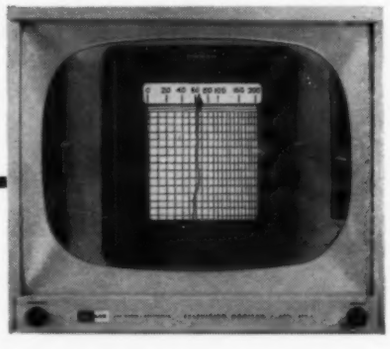
for laboratory performance combined with rugged durability, simplicity, economy . . . our nationwide staff of field engineers has experience in hundreds of installations . . .



Write or wire today for descriptive literature and demonstration

KAY LAB

5725 KEARNEY VILLA ROAD
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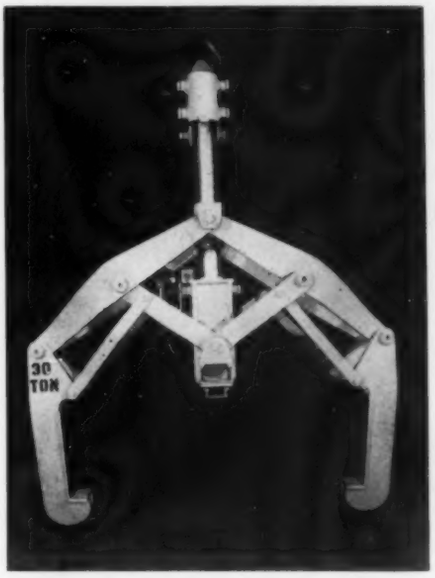
MOTORIZED TONG



Designed by Heppenstall Co., is this new type of motorized horizontal coil tongs for use where side clearance is limited. An electric motor, controlled by the crane operator, opens or closes the arms as required for picking up a coil and holding it firmly while lifting it. The linkage is such that the arms are parallel to each other at all times, whether opened or closed. Models which rotate the coil keeping the axis parallel to the floor are also available. These tongs have a capacity of 30 tons and can be used for lifting coils up to 76 in. wide.

assembled, even after years of severe service. Chemlon pipe joint compound is particularly adaptable for use on aluminum, stainless, monel or plastic pipe and is currently available in 2-oz screw-type jars.

RAIL CLAMP

▲ A new self-adjusting automatic rail clamp has been unveiled by the Mead-Morrison Division of Mckiernan-Terry Corp. that provides a number of safety and operating advantages previously unavailable. A noteworthy design feature allows a clamping force to be applied directly by a spring which is released during operation by a hydraulic cylinder when the structure is in motion.

In operation, a compression-type spring works directly on the clamp jaws to apply pressure through serrated shoes to the rail head. The clamp is released by purging oil to a hydraulic cylinder that applies force to compress the spring. The pump motor is wired through the propel-

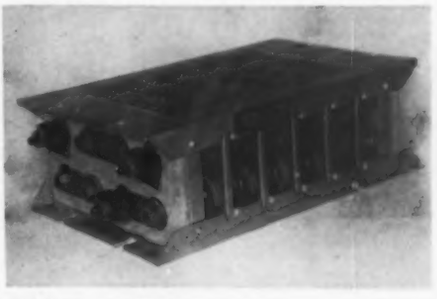
GUYAN RESISTORS

Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

For complete information on Guyan Resistors, please contact the nearby Guyan Representative or our main plant at Logan, W. Va.

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Buffalo, N.Y.—Buffalo Electric Co. West Mohawk St.

Chicago, Ill.—John K. Byrne, 1515 W. Howard St.

Cleveland, Ohio—Mechanical Equipment Co. 3100 Prospect Ave.

Detroit, Mich.—Plant Equipment Co., General Motors Bldg.

Philadelphia, Pa.—George I. Wright 811 Commercial Trust Bldg.

Pittsburgh 27, Pa.—P. R. Holden, 4860 Elmwood Dr.

●

GUYAN MACHINERY COMPANY

LOGAN, W. VA.

ling master and operates in conjunction with it. Thus, placing the propelling master on the first point in either direction actuates the clamp pump motor and hydraulically releases the clamp in from 3 to 5 seconds. At this time the propelling circuit is established through relays by the rail clamp limit switch. The clamp is held open as long as the propelling master is in the "off" position.

When the propelling master is placed in the "off" position, the pump motor automatically stops, a solenoid bypass valve opens relieving the hydraulic cylinder, and the rail clamps grip the rail. To prevent unnecessary wear and damage to either rails or clamp, an adjustable metering valve is provided that delays the clamping action until the bridge or tower comes to rest.

This clamp is self-adjusting, to accommodate rail head variations and wear on clamp shoes, and is free to follow horizontal or vertical rail variations. Normally no special sill construction is required, as the mechanical parts can be installed under a sill 29½ in. or more above the rail. The hydraulic releasing unit can be mounted at any convenient place on the sill.

An important feature of the clamp is that it is made to fail safe. Any hydraulic or electrical system failure cuts the propelling circuit and sets the clamp. The structure then cannot be moved until the failure is corrected and the clamp is fully released.

MEASURING UNIT

▲ An electronic potentiometer equipped with a pneumatic transmitter which sends a 3-15 psi signal proportional to the measured variable, has been announced by the Bristol Co.

The new Dynamaster Pneumatic Transmitter is available in either potentiometer or bridge circuits, and will measure any variable which can be translated into an electrical quantity. It then converts the measurement into a universal 3-15 psi pneumatic signal for transmission to a remote pneumatic indicator or recorder, or automatic controller. Thus, it is possible to present measurements such as speed, viscosity, pH, resistance, smoke density, current and voltages, frequency, and conductivity, etc., on the new miniature pneumatic receivers, along with more conventional measurements of flow, pressure, and temperature.

Standard Bristol electronic and pneumatic components are used in the new instrument. It is available either "blind" or with an indicating scale for at-the-scene measurement.

THERMOMETER

▲ Royco Instruments has announced the availability of a rapid, contact-type thermometer capable of indicating surface temperatures on a one-second contact. The "Pyro-Couple" offers a wide range of usefulness in checking the temperatures of liquids or solids including insulating materials.

The unit combines a surface-contact thermocouple and an indicating meter damped for quick reading,

Pure Copper Castings
Tuyeres • Tuyere Coolers
Cinder Notches
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(Heavy type—1 to 2 ton)
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Lawrence Tuyeres are precisely cast to fit smoothly and snugly into the cooler. At installation this saves both time and additional machining costs so often necessary with less expertly made Tuyeres. Since 1888 many of America's large steel mills have continuously used Lawrence Tuyeres for their high quality and complete dependability. Try Lawrence Tuyeres in your blast furnaces. You'll appreciate what their neat fit and high quality means in terms of easy installation and longer life. When in the market, try Lawrence Tuyeres. Write today.

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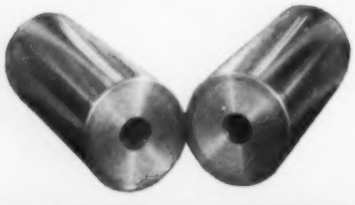

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shock resistance, and pointer stability. Waterproof construction of the stainless-steel probe permits use in a wide range of fluids. For special requirements, probes can be made any length up to 60 in. for such applications as scanning areas or volumes of liquids.

For convenience the scale is calibrated over its 0—650 deg F range in both Fahrenheit and Centigrade, scale accuracy being 2.5 deg F (A 0—1000 deg range is available, as well). The scales are linear with no crowding at the upper end of the 2⅜-in. arc.

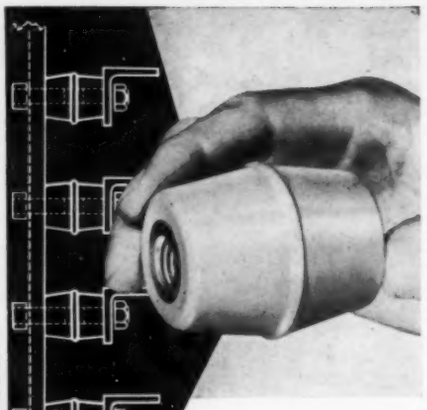
Other features include automatic compensation for ambient temperature permitting readings to be taken almost anywhere; complete portability due to freedom from batteries or external connections; an unbreakable plastic meter face and a screw-on probe-protecting shield. Total weight of the unit including shield is 12 oz and total length without shield 8 in. Maximum diameter is 2½ in.

HEATER

▲ A new heater for supplying fresh, properly warmed air to a building or room is announced by L. J. Wing Mfg. Co.

Known as the Wing FAS Unit Heater, it consists of a motor and fan, a heater section comprising alternate heating and by-pass passages and a distributing outlet. Air brought in through the heating passages passes over extended surface steam coils. Air brought in through the by-passes is not heated.

Volume control dampers on all passages, operated by synchronized damper motors, are actuated by an air stream thermostat or room thermostat. Dampers on the heating passages move toward "open" position and dampers on the by-passes move toward "close" position or vice versa, depending on temperature requirements. When the temperature of the outside air is lower than the desired inside temperature, the dampers on the heating passages open and those on the by-passes close to the degree necessary to produce the required temperature. The blended discharge air stream is maintained at an even pre-determined temperature and constant volume. Because the spring-return feature closes both sets of



NEW INSULATOR FOR TRAVELING CRANE TROLLEY FEEDER CONDUCTORS

Cuts Installation Costs 56%

Red Seal's new polyester "504 insulators" are replacing hardwood conductor posts on trolley feeder runways at tremendous cost savings. One example, the installation sketched here, cost $8.80. It replaced a conventional installation of hardwood conductor posts and spacers costing $20.00.

The "504 insulator" is made of polyester, reinforced with fiberglass, and is practically indestructible in regular heavy duty use. Two tapped inserts of cadmium plated, machined steel make installations easy—yet will not pull, vibrate or turn loose.

Fiberglass reinforcement gives high tensile, compressive and cantilever strength, as well as excellent impact resistance. Polyester binding material makes insulator resistant to moisture, dirt, corrosion, electrical arc and heat.

Designed for service to 1000 volts, the "504" is the smallest insulator available, measures only 1⅞" dia. by 2¼" long. Each insulator, is carefully inspected and tested at 10,000 volts before shipment.

For full details, write today

RED SEAL ELECTRIC CO.

6321 Detroit Ave. • Cleveland 2, Ohio

FILE No. 176

the case of-- THE BEARING THAT HOISTED MEN AND COAL FROM THE MINE

A few minutes before a change in shifts in a large, busy southern Illinois coal mine*--it happened again! The empty cage was making a return trip down the shaft. Suddenly, half-way--it jerked to an abrupt halt. And there it stuck. Again a critical bearing in the cage operating equipment had burned out.

A replacement bearing was installed. But--what if it too burned out--at the wrong time? Serious trouble, even disaster could result. The superintendent phoned this company's bearing representative--who immediately drove to the mine. Working with the operating and maintenance crews--the cause of the repeated bearing failures was determined. Corrective measures were suggested. And, there hasn't been a similar bearing burn-out since.

The personal interest and extraordinary cooperation evidenced in this case--is not unusual for this company. For years it has been company policy to give customers the utmost in service. That's why expert Bearing Engineering Service is available whenever needed...Bearing Surveys may be had for the asking...and...ALL for the price of the bearings. For bearings--with service PLUS--dial the number below.

TIMKEN
One of the famous brands of bearings and specialties regularly carried in stock--for IMMEDIATE DELIVERY

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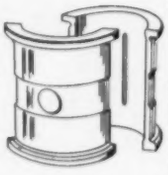
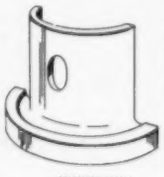


For years Flood City has furnished quality bronze parts at a savings in metal weight and machining costs to a variety of industries.



We welcome your inquiries concerning quotations and delivery on your bronze parts needs. Our reply will be prompt — and there is no obligation.

Be sure it's the BEST - specify FLOOD CITY

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dampers when the fan motor stops, separate shut-off dampers are not required.

The steam pressure in the coils is the same as in the supply main at all times. Consequently the coils cannot freeze and burst, as is always a possibility where steam pressure is modulated to regulate temperature.

Book Reviews . . .

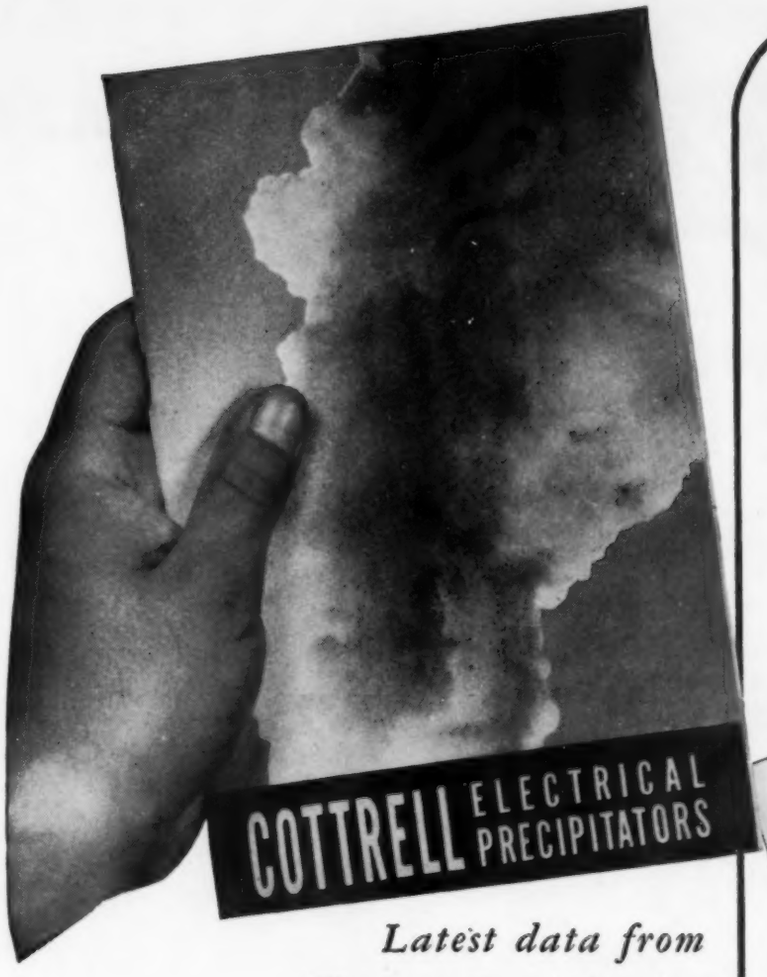
"ASTM Standards on Light Metals and Alloys, Cast and Wrought," is available in a third edition from the American Society for Testing Materials Headquarters, 1916 Race Street, Philadelphia 3, Pa. The book contains 276 pages, 6 x 9 in., has a heavy paper cover and sells for $3.50. The publication is sponsored by the Society's Committee B-7 on Light Metals and Alloys; and, in addition to the specifications and methods of testing under the jurisdiction of this committee, also includes similar data under the jurisdiction of the committees on Die Castings, Wires for Electrical Conductors, Methods of Testing, and Chemical Analysis of Metals as well as the Joint AWS-ASTM Committee on Filler Metal. The book contains the Society's standards on ingots, castings, bars, rods, wire, forgings, pipe and tube, sheet and plate, wrought products for electrical purposes filler metal, electroplating, and general methods of test; the ASTM codification system for light metals and alloys is also included.

"Legal Problems in Engineering," by Melvin Nord, has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y. The book contains 391 pages, 5½ x 9 in., is cloth bound, and sells for $7.50. The author is a consultant in law and engineering, a member of the Detroit and Michigan Bar Associations, and a registered engineer in New York and Michigan. The book has a broad scope and coverage and deals with many legal subjects that have bearing on engineering, treating each subject deeply and thoroughly. The book is primarily on legal problems and the treatment is so, though economic aspects are never discounted. Case material presentation is a special feature of the book, and while the voluminous "case book" approach is not followed, the book uses its cases to illustrate the discussion and to point up the legal problems possibly encountered in given circumstances, with presentation given in a condensed form to avoid unneeded side issues. Legal jargon is kept to a minimum and contents should be worthwhile to a nonlawyer seeking a concise, reliable survey of the field. Mr. Nord prepares the Patent Review feature monthly for the Iron and Steel Engineer.

"Resistance of Materials," fourth edition, by Fred B. Seely and James O. Smith has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y. The book contains 459 pages, 5½ x 8¼ in., is cloth bound, and sells for $6.50. This fourth edition is essentially a new book and emphasizes the solution of real engineering problems. The book aims at making the theory of resistance of materials more self-sufficient and at developing more logical methods of analysis and design. The contents are divided into two general parts; elementary topics, including such factors as relations among loads, stresses, and deformations, bending loads, torsion of cylindrical bars, stresses in beams, deflection in beams, and the like; additional topics on such factors as composite beams, reinforced-concrete beams, unsymmetrical bending, double-integration method for deflection of beams, etc., are also discussed. The book is abundantly illustrated with line drawings and illustrative problems.

"Electronics—The Science of Electronics in Action" by A. W. Keen is a new publication by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 256 pages, 5½ x 8 in., is cloth bound, and sells for $7.50. The author has attemped to present in elementary but accurate terms an up-to-date and comprehensive account of electronic devices and their applications. It is presented in an "in-between" category and one having a sound knowledge of elementary electricity and magnetism will be able to obtain a clear idea of the nature and scope of the subject. The treatment is entirely descriptive and inevitably superficial, but should enable the reader to progress to less elementary and more specialized literature.

(*Please turn to page 238*)



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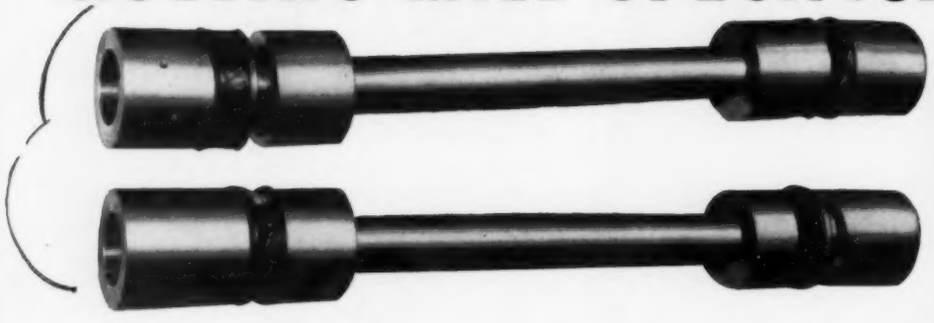

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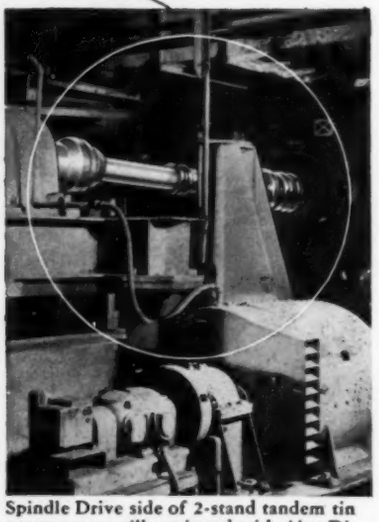

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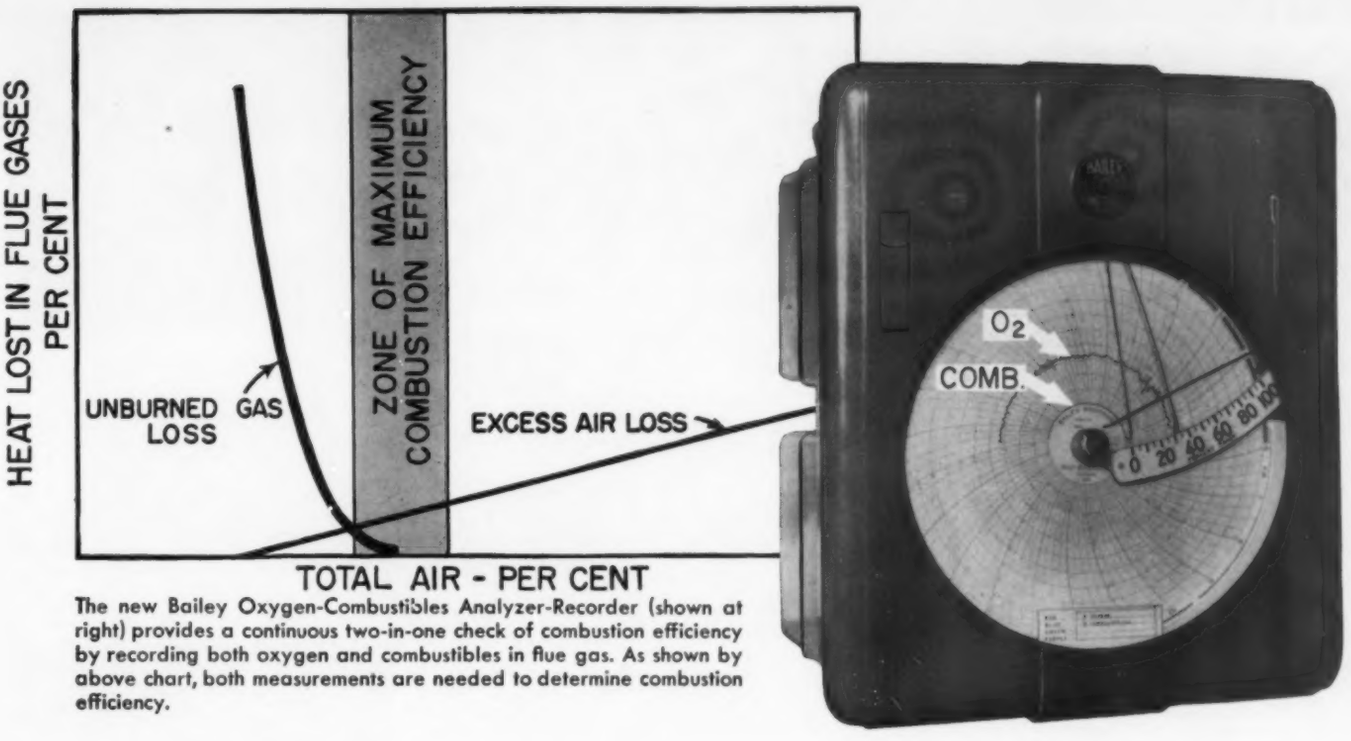

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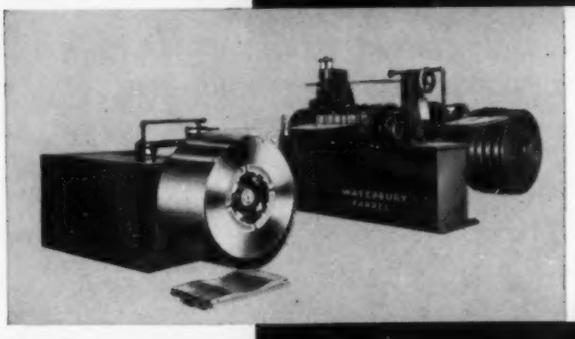
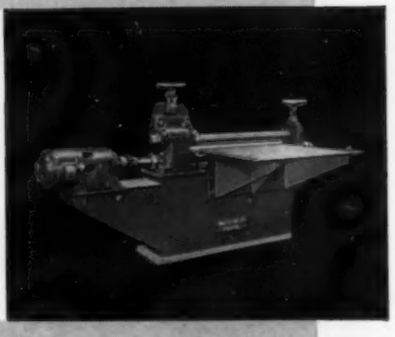


Gang slitting line consisting of payoff stand, coil lift, slitter and winder—built in various sizes to handle a wide range of gauges and widths.



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BOOK REVIEWS

(*Continued from page 232*)

"**Steels For The User,**" third edition, by R. T. Rolff, has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 399 pages, 5¼ x 8¾ in., is cloth bound, and sells for $10.00. This third edition has been brought up-to-date and is completely revised throughout. The book is highly practical and based on long practice for carbon steels in industry. The scientific aspects of the various processes are comprehensively treated and illustrated by ample data and examples from actual service. This work deals substantially with carbon steels. Alloy steels, nitriding steels, and high temperature service steels are discussed only for duties for which carbon steel is unsuitable. The book is aimed at the practical man who can benefit from the experience of others and from simple explanations of complex processes. The book emphasizes British practice.

"**Transactions Bulletin No. 29, Industrial Hygiene Foundation, 20th Annual Meeting,**" has recently been published by the National Hygiene Foundation of America, 4400 Fifth Avenue, Pittsburgh 13, Pa. The book contains 274 pages, is paper bound, and sells for $5.00. This is a complete presentation of the transactions of the general meeting covering six conferences on medical, chemical-toxicological, joint medical and chemical-toxicological, legal, engineering, and joint engineering and legal subjects, held at Mellon Institute, Pittsburgh, Pa. on November 16 and 17, 1955. Papers read during these sessions are contained in this book as well as discussions involved; tables, graphs, and some photo illustrations are employed and numerous references are cited.

"**Manual of Excellent Managements, 1956**" has recently been published by the American Institute of Management, 125 East 38th Street, New York 16, N. Y. The book contains 192 pages, 8½ x 11 in., is cloth bound, and sells for $20.00. It is divided into three parts. First, an analysis of the management audit is rounded out in eleven phases. Secondly, a full scale management audit of the Aluminum Company of America is presented. This management audit illustrates the application of the principles discussed in the first part, and, at the same time, presents the management record of one of the outstanding large companies of the United States. Thus, it makes available for study the success of the Aluminum Company of America for the benefit of those concerned with the results of sound management techniques. The third part of the book is a list of 409 excellently managed companies of 1956.

"**Precision Electrical Measurements,**" data presented at an international symposium in November 1954, at the National Physical Laboratory, Teddington, Middlesex, England, has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book is 8½ x 11 in., is cloth bound, and sells for $12.00. These proceedings are divided into five parts dealing with techniques applicable to electric fields and dielectrics, magnetic fields and associated materials, electrotechnical measurements, standard techniques for high-voltage measurement and for impulse-testing. For example, the first session is comprised of five papers on capacitance and dielectrics; the second session, six papers on inductance and magnetics; the third session, five papers on electrotechnics; the fourth session, four papers on high-voltage measurements; and the fifth session, six papers on high-voltage impulse testing techniques.

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This feature solves many problems where excessive misalignment becomes unavoidable, such as coupling arrangements which necessitate changing centers of rolls etc., or any sort of drive requiring more than the standard plus or minus 1°.

The method by which this is done represents the very latest gear cutting process. Gear teeth cut by this amazing and ultra modern method are not only to a precise and absolutely true shape, but are also generated to tolerances of astounding accuracy.

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CONVEYING 200 tons of molten iron from one location to another is a critical job. Precision engineered equipment is a must. Steady, never faltering control is required always—to turn the ladle left, right, completely over, back to center.

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Get full engineering data by writing for free Catalog 400. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

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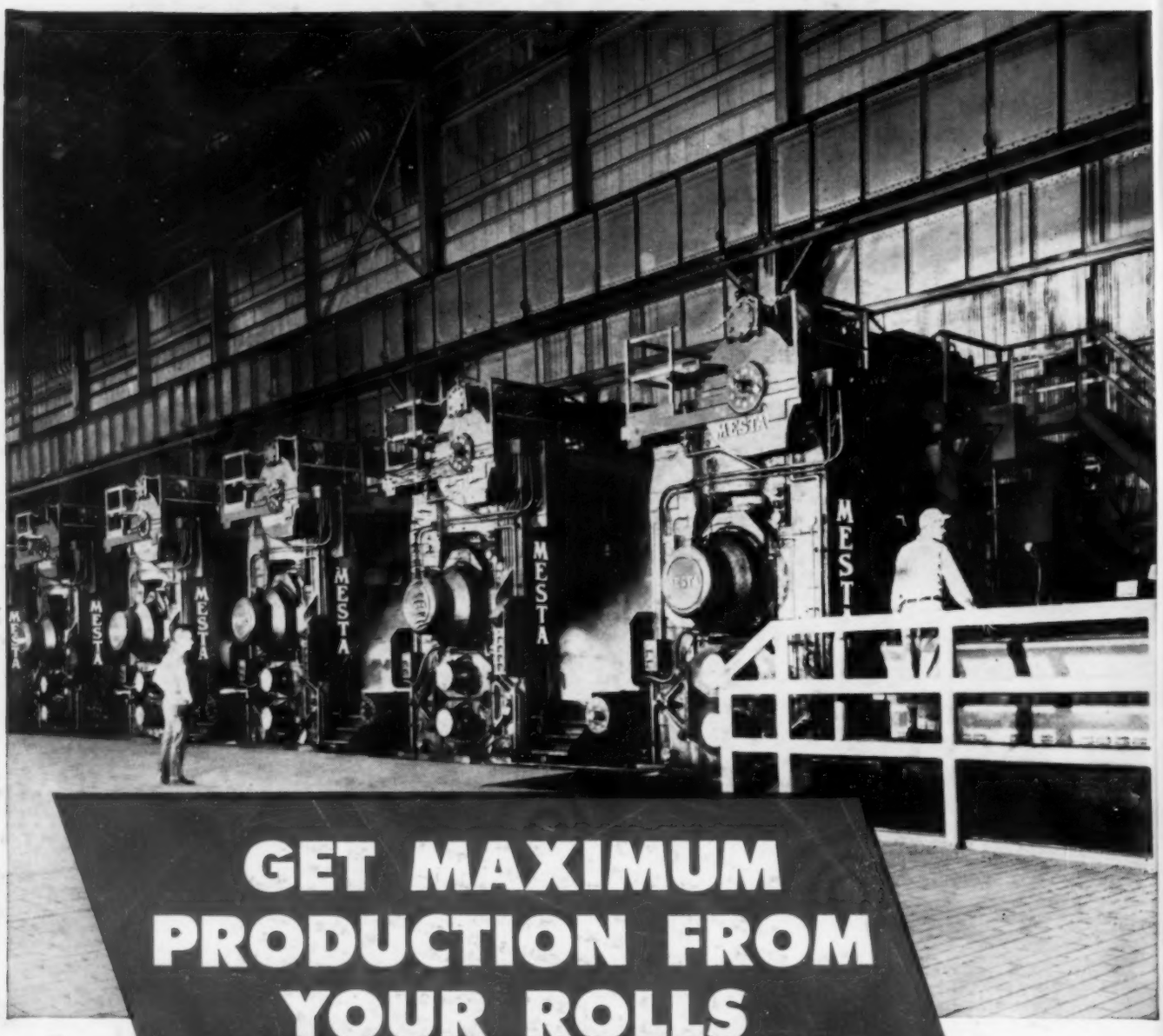

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